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FOR THE DESIGN, CONSTRUCTION AND ENJOYMENT OF UNUSUAL SOUND SOURCES

EXPERIMENTAL MUSICAL INSTRUMENTS

IN THIS ISSUE

SHOES AND SHIPS AND SEALING WAX

Our central offering in this issue is a big table of tunings, presenting scale systems from around the world and across the centuries in a single chart at the centerfold. Also included this time around are a look at the mechanical musical instruments of the early part of this century and related resources available today; some reviews; a few more odds and ends; AND the article that follows, on the design & layout, physics & playing technique for musical glasses. Read on!

NOTES ON THE MUSICAL GLASSES

By Ed Stander

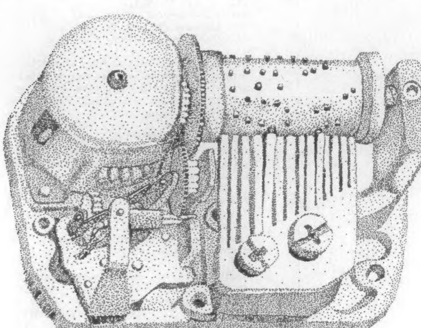
INTRODUCTION

The musical glasses (or "Angelica" as it was initially called) appears to have been invented by Richard Puckeridge of Ireland in 1743. During its heyday (circa 1750 - 1770), it was a common fixture in many European households, and only waned in popularity with the introduction of the Glass Harmonica. Yet, despite the obvious improvements inherent in this later design, the musical glasses continued to support a small but dedicated following throughout the 18th and 19th centuries. Reasons for this continued popularity probably included its low cost, when compared to the more complicated Glass Harmonica, and its ready availability as a finished product.

The glass instruments of yesteryear were simply constructed. The glass bowls (typically lead crystal) were mounted on thick, tapered stems which could be wedged into tapered holes drilled into a wooden base. No soundboard was required, as little of the vibration was able to pass through the stem.

The glass bowls themselves were

(continued on page 5)



Music Box Innards; drawing by Robin Goodfellow. See the article starting on page 18.

LETTERS

I ESPECIALLY ENJOYED Cris Forster's short article on plain string calculations. After having gotten some details on plucked string calculations from Donna Curry [Donna Curry's Music, 1780 Ft. Union Dr., Santa Fe, NM 87501] and from the Journal of the Lute Society of America, I decided to spring the concept of my high school physics class. I borrowed some old weights from the gym, bought some 1 x 4 and constructed half a dozen Pythagorean monochords. We spent 3 weeks finding the relationship between length, tension, string diameter and frequency. It was the scientific method in action -- taking data (using my electronic piano to measure frequency), graphing relationships, deriving and testing formulas. The Forster article gave me the information I needed to plan the lab with precision and keep my students hopping from one discovery to the next. What a coincidence that this issue arrived just as I was about to set the students to work. We all read through it afterward and even tested the tensile strength of our hardware store steel. It broke very near the predicted tension.

Ben Saferstein

I ENJOYED YOUR REVIEW of Jim Leonard's book on the musical saw Scratch My Back [Kaleidoscope Press, 1601 W MacArthur #12F, Santa Ana, CA 92704] and was also pleased to note the reference to several saw players whose work did not find its way into Leonard's otherwise quite comprehensive pages. The saw has a unique range of expression generally not explored in more traditional approaches to musicking. In addition to a fundamental tone produced at the highest point of the musical saw's curve, harmonics of that tone can be played simultaneously by bowing or striking at other points along the arched blade. This sort of "extended" saw technique has attracted the interest of a number of contemporary percussionists, many of whom have already tuned into similar phenomena in playing bowed cymbals. Thus, Paul Lovens (featured on many recordings from the Genova, Italy-based Po Torch label) cites the saxophone multiphonic techniques of Evan Parker as offering a point of entry into his own playing of the singing saw (as in the mysterious "Al-ith" solo on Weavers, Po Torch PTR/JWD 7).

In the hands of a number of contemporary musicians the saw sings with remarkable variety, far beyond the weird effects of a "singing sword" in one of Bugs Bunny's animated cartoon adventures or an ascending UFO on an old Bob and Ray radio show. Percussionist Roy Brooks plays exclusively with a mallet. I first heard him playing blues saw with Charles Mingus' band in the early 70s. (His performance on "Blues for Some Bones" can be heard on Charles Mingus Live in Chateauvallon, 1972, French INA FCD 134). More recently, Brooks has performed with Max Roach's ensemble M'Boom and can be heard on both recordings of this group: M'Boom (Columbia JC 37066) and Collage (Soulnote SN 1059). At Chicago's Grant Park Jazz Fest last year, M'Boom's set featured Brooks' sawing on "The Glorious Monster" and several remarkable solo choruses on "Body and Soul."

Moving further into more open-ended improvisation of the post-Albert Ayler continuum, percussionist Eddie Moore has utilized the saw extensively in various ensembles led by saxophonist Dewey Redman. At a reunion concert of Redman's trio with Moore and bassist Rafael Donald Garrett in Chicago six years ago I heard a wonderful duet of Moore's saw with bamboo flute played by Rafael Garrett. Moore's ensemble saw work can be heard on several albums with Dewey Redman: The Ear of the Behearer (Impulse AS-9250), Coincide (Impulse AS-9300), Musics (Galaxy GXY-5118), and Soundsigns (Galaxy GXY-5130).

Former Chicagoan Jerome Cooper was introduced to the saw by Eddie Moore in New York in the early 70s when Cooper was working with the Revolutionary Ensemble (with Leroy Jenkins, violin, and Sirone, bass). He plays saw to beautiful effect on his own composition "Ponderous Planets" (on RE's The People's Republic, A&M SP-708) and on Roscoe Mitchell's "Chant" in a trio with Mitchell and Don

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Moye (on Wildflowers 5, Douglas NBLP 7049). For solo performances, Cooper has composed music for saw, bells and harmonica.

Another active sawist in the New York improvisor's scene, Charles K. Noyes, has included the saw in performances with John Zorn (the duet "Augury" on The World and the Raw People, Zoar 12), Elliot Sharp, and many others. He brings the saw into unusual and beautiful combination with Korean kayagum (played by Sang-Won Park) and electric guitar (Henry Kaiser) in the trio Invite the Spirit (Invite the Spirit, Celluloid OAO CELL 5008/5009).

While the saw, after perhaps a hundred years of documented history, is no longer an experimental instrument, it remains a very unconventional one. With Scratch My Back's emphasis on traditional, folk, popular and light classical musics, the more unconventional aspects of saw playing have been overlooked. Even in the 20th century classical repertoire the saw makes scattered appearances in works by Penderecki, George Crumb, Henri Sauguet, and many others. In at least one performance of Crumb's "Ancient Voices of Children" the saw part was played by Jim Turner, whose LP The Well-Tempered Saw (Owl Records ORLP-22) includes, along with traditional tunes, David Burge's "Serenade for Musical Saw and Orchestra" and Bill Perkins' "Textures for Musical Saw and Percussion.") Jim Leonard has published a fine beginning, but much remains of musical sawing to explore and document. From Wobbly philosopher and organizer Tom Scribner (included in Leonard's book), through the blues of Roy Brooks, to the scores of remarkable saw players in all styles and traditions, the saw maintains its presence on the cutting edge of musical discovery.

Hal Rammel

I READ WITH INTEREST the theories of the origins of the "cat piano" instrument -- played using a piano action to strike the tails of "an octave" of cats. Using animals in such a manner is not only inhumane, but certainly cannot result in any musical accuracy. However, the letters did remind me of my own research in Animal Music -- the original AM.

After discovering the percussive sounds produced by playing dogs in a conga-like manner ("Doggie Drums"), other historical efforts of producing sounds using animals began to reveal themselves. Attached are a few items that may be of interest to readers.

Drawing 1A: Dr. Rudolf Spengler, a noted researcher in Animal Music, performing on one of his early instruments, the Fish-O-Phone, using a type of seahorse as a vibrating chamber for a series of oscillating tones produced by blowing through his beard.

Drawing 1B: Although now considered inhumane, in early vaudeville days, entertainers tap danced upon live crocodiles, whose grunts of displeasure offended too many audience members to last very long.

Drawing 2A: The Long-Necked Giraffe Trumpet, a traditional instrument in the Kalahari Desert, has been updated by the use of common trumpet parts. It is now becoming an essential part of the Afro-Pop style of music.

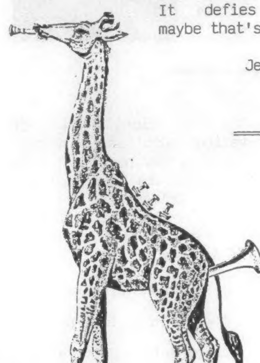
1A

1B

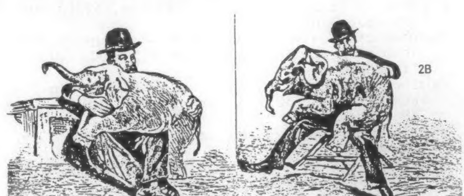
Drawing 2B: Two methods of playing an elephant are shown. Although a seated position was best, a semi-prone position allowed the "phant" to be played for longer periods. For some reason, Irish music was an extremely popular style on the elephant.

Animal music, you see, is not new. It's not too old either. It's a musical form that ... that ... that's just it. It defies explanation. And maybe that's for the best.

Jeff Brown



2A



2B

NOTES FROM RECENT CORRESPONDENCE

There have been recent articles in The Gourd (PO Box 274, Mt. Gilead, OH 43338) describing instruments made by T.N. Garland of Elizabethton, Tennessee. In 1963 Mr. Garland happened across the handcrafted Appalachian dulcimer that his grandfather had made and played many decades before. The instrument's body was comprised of a single large gourd. Garland took measurements from the instrument, now too fragile to be played, and made a copy. He went on to make dozens of gourd dulcimers.

Editor of The Gourd, Ted Modrowski, was good enough to send along the photo reproduced here showing two of Mr. Garland's instruments. Holding the dulcimers in this photo is Noah Richardson. In Garland's instruments there is no separate soundboard; the body of the gourd is left in its natural form and the entire rounded surface radiates sound. The neck, made of a separate piece of wood, passes through a hole cut in the top of the gourd and into the interior. Some of Garland's instruments use gourds with long necks curving off to the side from the fretboard -- an odd visual effect, but just as effective for sound.

Arthur M. Scholtz has sent along a list of contact addresses for various suppliers, information sources and the like that may be of value to readers. Someday EMI may manage to pull together a comprehensive instrument experimenter's resource guide, but since someday may not arrive for quite some time, we'll get a small head start by printing Arthur's information now.

Theremin User's Group: Eric Ross, 259 Oak St., Binghamton, NY 13905.
The Tuba Exchange: 1825 Chapel Hill Rd., Durham, NC 27703; 1-800-TUBA.
Log drums, conch shells, etc.: Hula Supply Center, 1346 South King St., Honolulu, HI 96826.
Skin for drumheads & banjo heads: United Rawhide, 1644 N. Ada St., Chicago, IL 60622.
Free ads & electronic parts search: Electronic Musician, c/o Craig Anderton, Operation Help, PO Box 3747, Escondido, CA 92025.
Ondes Martenot maker: Ecole d'art Martenot, Monsier Maniere, 23 rue Saint Pierre, 92200 Nevilly Sur Seine, France.
Recordings of Ondes Martenot & Glass Harmonica: Thomas Bloch, 9 Rue de Castelnau, 68000 Colmar, France.
Southwest Michigan Musical Saw Festival: c/o Mr. Lee Derksen, 323 Allegan St., Plainwell, MI 49080.
Buchla (synthesizers) and Associates: PO Box 1025, Berkeley, CA 94709.
Lap Steel Guitars: Matses St. Guitars, Box 334, 20 Essex St., West Boxford, MA 01889

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NOTES ON THE MUSICAL GLASSES

By Ed Stander

"Musical glasses" refers to a graduated set of glasses -- most often in the form of wine glasses, with narrow stems and bowl-shaped tops -- arranged to produce a scale of musical pitches. Musical glasses, as well as glass or ceramic bowls, have been played by percussion in Europe and Asia for centuries. It's no secret that they can also be sounded with friction, by running a moistened finger around the rim to produce a continuous singing tone. In this mode of playing the glasses came into their own as a popular musical instrument in 18th century Europe. In 1761 Ben Franklin mechanized the idea by nesting a graduated set of glass bowls in a row on a horizontal rotating spindle operated by a treadle, thus bringing the rims in closer proximity and making possible the performance of more complex music (see Experimental Musical Instruments Volume II #4, "The Glass harmonica"). Yet while Franklin's Glass Harmonica has cast a long shadow, there have always been those who continue to play the original way, creating their own instruments from sets of glasses standing upright in a horizontal array. Ed Stander is one of these. His account continues:

GLASSES, continued from page 1

sold either "tuned" or "untuned", depending on the price one wished to pay for them. The tuned glasses were fortuitously blown to the right pitch, while the untuned glasses required the addition of a fixed amount of water prior to playing. The relative placement of glasses was simple as well, with most instruments following the model set by the piano (i.e. the accidentals placed above the natural notes). This limited the versatility of the instrument, and precluded the performance of such complicated pieces as the Adagio and Rondo for glass harmonica and orchestra composed by Mozart in 1792.

And so the matter rested until 1938, when Bruno Hoffmann introduced his "glasharfe", a 48 note instrument spanning 4 octaves. Unlike its ancestors, the glasharfe was much more versatile, the glasses being arranged such that triads could be played with one hand, provided that one's fingers were long enough (see figure 1). This improved geometry allowed complicated pieces such as Mozarts' works to be played for the first time on the glasses, as indeed they were.

However, due to the limited finger span of most human beings, the glasses in Hoffmann's glasharfe had to be specially blown with straight walls. If not, one would never be able to reach over the middle glass to sound the thirds. This, unfortunately, took the instrument out of the realm of the average musician, and placed it squarely in the court of the glassblower and/or rich financier. In an effort to return the serve, I present here a new variation of the glasharfe which can be built without the aid of the neighborhood glassblower, and is easier to play as well.

GLASS PHYSICS

The basic sound producing unit of the musical glasses is the glass bowl. This bowl is set to resonating by rubbing a clean, moistened finger about its rim. The stick-slip motion of the finger introduces the vibration into the glass.* In vibrating, the bowl behaves like a three-dimensional tuning fork, with opposite points on the rim alternately flexing in toward one another and out away from one another. The stem of the bowl, while not absolutely necessary, improves the volume and quality of the sound by supporting the glass at the point of least vibration.

The note produced by a given glass depends on the mass of the glass, not the volume of air contained within. For those who do not believe

* "Stick-slip" refers to the frictional vibration-inducing system characteristic squeak-like sound sources, as well as violin bows: as one surface moves along the other, the vibrating body repeatedly flexes along with the motion and then, reaching a certain level of distortion & tension, jumps back, repeating this pattern at the natural vibrating frequency.

ED STANDER'S MUSICAL GLASSES

this, try playing a wine glass as it is being filled. As the water fills the glass, the frequency of the note decreases. If it was the volume of air in the glass which defined its resonant frequency, the pitch of the resultant note would be raised. Instead, the water in the glass acts as a coupled spring which increases the effective mass of the bowl, and therefore decreases its pitch.

The wall thickness of store bought glass is rarely constant, but varies somewhat from place to place along the rim. As a result, some glasses are able to produce more than one audible tone. While these tones rarely differ greatly in frequency, they can create a sort of tremolo effect as one constructively or destructively interferes with the other. This effect can be a bit disconcerting if too pronounced, but in small quantities is quite pleasant to listen to. Control of the tremolo is provided by varying finger pressure on the glass rim (loudness), and by the velocity of finger rotation (speed).

INSTRUMENT DESIGN

In Hoffmann's glasharfe, three fingers come into play: the Thumb, the Middle Finger, and the Pinky. Triads are played by stretching these fingers to the utmost, and rotating each about their respective glass (see below). This movement requires much practice to perfect, and, as mentioned above, straight sided glasses are required. In my instrument, the same three fingers are used, but the hand remains in a more relaxed state. This is accomplished by placing the triads at the apex of a right (rather than isosceles) triangle (figure 1). In this geometry, the dominant note is located on the right angle, and is played by the Middle Finger. The third is placed to the left of the dominant note and is played by the Thumb or Pinky; while the fifth, placed directly below the dominant, is played by the remaining appendage.

By dint of this geometry, we can produce a fully chromatic, transposable 2 1/2 octave instrument by placing 60 store bought glasses at the intersection points of a 5 row, 12 column grid (figure 2). This produces a much larger instrument than the Hoffmann glasharfe, as it requires some redundancy in notes. However, I believe this failing is minor when compared to the improved playability of the instrument.

Choosing glasses for this instrument is a bit of a lark and smacks of exhibitionism. I personally frequent several venues, including glass stores, florists, shopping malls, and rental/catering services. At each locality I inconspicuously cart out my chromatic tuner and bottle of water, and quietly audition glasses. This generally attracts the attention of the local clerks and customers, and has given me quite a reputation over the years.

Finding the right glasses requires a lot of patience but can be inwardly rewarding. Hand blown glass (Bulgarian, Mexican, etc.) is the best choice, as a whole range of notes may be found in a single carton of goblets. Machine blown glasses should also be tested, but they tend to be more limited in tonal variability. The 19 oz. Luminarc ballon glass, for example, invariably produces a D note.

Glasses come in a plethora of sizes and shapes. In my instrument I have tended towards cheap, ordinary glasses having robust stems, spherical bowls and little or no thickening along their rim. Glass height, which may vary by an order of magnitude, may be equalized by cutting the glass stem with a glass cutter, and then epoxy potting the remaining stem + bowl into a 1/2 inch threaded brass pipe fitting (photo at right). This turns each glass into a giant screw which can be directly fastened to a drilled and threaded plexiglas sheet.

The time required to produce such an instrument? My 60 glass Angelica, tuned to concert pitch (plus or minus 5 cents) and requiring no water in any of the glasses, has taken approximately three years to assemble. The cost, while still less than a glass harmonica, is rapidly approaching the halfway point.

PRACTICAL ASPECTS OF PLAYING

Most people have probably tried to produce sounds from a wine glass at least once in their lives. In general, these first attempts are not terribly successful, and can easily put one off playing for life. I well remember the first time I rubbed the rims at my cousin's wedding: I worked at the glass for an interminably long time to produce what amounted to a horrific, squeaky sound reminiscent of chalk on a blackboard. It's hard to believe that Beethoven or Mozart would consider writing for such an instrument.

BELOW: FIG. 1. The basic glass position in the A) Hoffman Glasharfe and B) Stander Angelica. Dashed triangles give the position of a representative triad.

AT RIGHT: FIG. 2. Set up for the Angelica, 1986 model. The bottom row, while not absolutely necessary, simplifies the playing enormously.

FIG. 1

A) B)

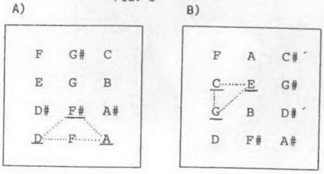
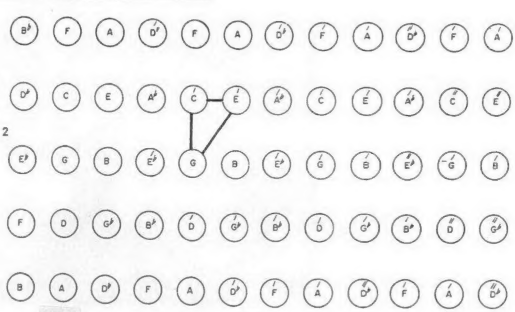


FIG. 2



MOUNTING JIG FOR POTTING MUSICAL GLASSES.

The jig holds the glass upright with the stem set in a short threaded pipe (bottom center) filled with epoxy. This gives the glass a base that can be screwed into threaded holes for easy mounting or removal.

In fact, the itinerant glass player is really faced with two imposing tasks. First he must learn to produce sound by the application of finger to glass, and secondly, he must learn how to produce a tone which doesn't send his audience running for cover.

Basically, the glasses are played by rubbing the fleshy part of a wet finger or thumb along the rim of a wine glass. This produces the stick/slip motion required to get the glass vibrating. This much is usually understood by the average wedding guest. What the guest doesn't realize is that there are actually three distinct factors controlling sound production.

First, the fingers must be clean and free of oils. This is usually accomplished by washing the hands with a detergent soap, such as that used for washing dishes.

Secondly, the water used must be hard, and in this instance, the harder the better. Hard water contains an abundance of dissolved calcium, which aids in the removal of natural oils and helps keep the glass "squeaky clean". To test the hardness of the local water supply, wash your hands and see how long it takes before you can snap your fingers. The longer it takes, the softer the water. I've played in a number of cities around the world, and have been able to support this relationship with experimental observation. Do not attempt to play glasses in Tokyo, Japan or Halifax, Nova Scotia.

Finally, the playing rim of the glasses must be highly polished. This is generally the case for new glasses, which receive a fire glaze as part of their production. However, with continued rubbing, this polish fades and the glass rim may become pitted and scratched. If the glasses are made of pyrex, a quick fire glazing in the flame of a propane burner can return the glass to its original state. If not, mechanical polishing using a buffing disk, hand drill, and a plastic/steel stick polish will accomplish the same end. In my case, I've found it necessary to polish each glass at least once a year.

Once the glasses are polished, grit residues must be removed by applying a bit of varnish solvent to the rim with a clean cloth.

Other factors quoted as affecting the sound quality in the past have included blood temperature and skin texture. However, I've not found these factors to be of major importance, although water (and therefore skin) temperature does have some effect: warm water makes the sound more "brassy", while cold water softens the sound.

On the subject of tone, glass bowls have two modes of vibration which tend to produce a strong sound. Deftly moving the finger around the rim, with no sideways slippage, produces the preferred mode for musical purposes. The other mode arises when the finger fails to trace the rim accurately, and runs at an angle or in a transverse movement. The overtones created by this mode are enough to send a cat half way to the moon. In playing, try to accentuate the former mode and (at all costs) avoid the latter. Your public will thank you for it.

FINAL COMMENTS

After a long, tranquil sleep, glass music may be once again coming into its own. It's not an easy world to break into, but does have various finite rewards. The music is certainly unique, and the concentration required to play a large instrument can set one firmly on the road to Zen enlightenment (whatever that is). I recommend it.

Glass music is also creative. There is no one presently mass producing the Angelica, or glasharfe, and so each instrument is unique and representative of its creator. The instrument I've described here is certainly not the final word in glasses. I present my work as a starting point for others, and welcome all suggestions as to improvements with an open mind (in particular with respect to the positioning of glasses).

Please send any comments and suggestions to Ed Stander at 94 rue de L'Espinay, Quebec City, P.Q. Canada. G1L 2H5. An example of glass music on cassette is also available from this address for the modest sum of $10.00 (shipping included).

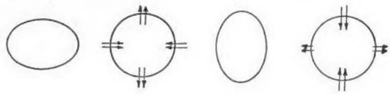
THE PHYSICS OF MUSICAL GLASSES

From the editor: In preparing to publish this article, we solicited comments on musical glasses and their vibration patterns from Donald Hall, a professor of musical acoustics, and EMI's frequent referee on technical matters. The following diagrams and notes are based upon the observations and sketches he sent in response.

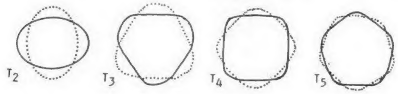
Like most vibrating systems, musical glasses can be expected to be capable of several modes of vibration, each with its associated frequency. Some of these modes, by the nature of their motion, are likely to be fairly efficient at moving surrounding air and thus making themselves heard. Others will have negligible effect on surrounding air and therefore produce little sound.

In musical glasses, the most important set of vibrational modes for musical purposes appear to be the transverse modes. These modes manifest themselves as the flexing of the rim so that certain sections flex inward as others accommodate by flexing outward. The diagram shows this motion

by means of a top view of the rim of the glass shown at sequential points in time with the vibrational movement exaggerated for clarity.



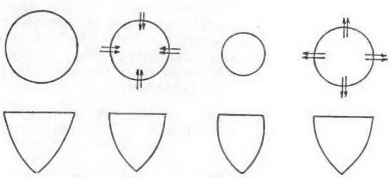
ABOVE: Sequential representations of rim shape (exaggerated for clarity) for transverse mode T_2. Arrows show direction of movement. This shows one complete cycle, which then repeats.
BELOW: Representations of rim shape for 4 transverse modes, each shown at two extremes (solid and dotted lines).



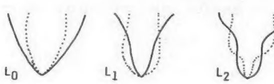
As you can see, many such transverse modes are possible, each distinguished by the number of sections of opposite motion the rim divides into (i.e., the number of nodes and antinodes). It is likely that the transverse mode identified as T_2 is the important one for musical purposes -- the one that predominates in musical glasses that are behaving as we want them to, and the one that results when we rub the rims in the manner that author Ed Stander coaches. Higher modes (T_3, T_4 and up) may be present as quieter overtones (although musical glass tone at its ideal does not manifest strong overtones). The theoretical T_1, not shown above, would correspond to the entire rim vibrating back and forth in unison, i.e., the upper portion of the glass moving right and left on the stem. This mode doesn't appear to be a major contributor to the sound of musical glasses.

It is easy to envision how striking the side of the rim would excite the transverse modes. It is more difficult to imagine that rubbing them would do so. But there are, Professor Hall notes, indirect mechanisms by which rim rubbing motion could translate into transverse vibration. To support the idea that the desired musical sounds correspond to the predominant transverse vibration mode, we can mention that the desired rim-rubbing pitch is the same as the side-struck pitch.

In addition to the transverse modes, one can expect longitudinal modes as well. "Longitudinal" is used here in a sense slightly different from it's common speech usage: the distinguishing factor is the occurrence of compression and rarefaction of the vibrating material (which is not a significant factor in transverse vibrations). In

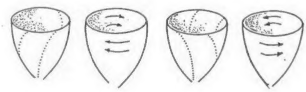


ABOVE: Sequential representations of rim shape and wall shape for longitudinal mode L_0, showing one full cycle.
BELOW: Representations of wall shape for 3 longitudinal modes.

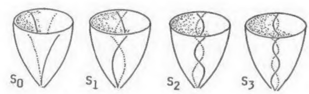


most solid media, glass included, compression waves travel extremely rapidly, resulting in much higher frequencies than transverse vibration in the same object. The unwanted high-pitched screech Ed Stander describes in his article, associated with cross-ways motion of the finger on the rim, may be a manifestation of the L_0 mode diagrammed here.

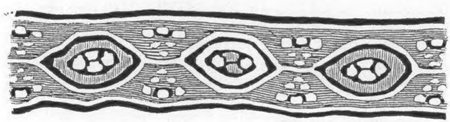
Professor Hall mentions a third set of modes likely to arise in rubbed musical glasses, which can be called shear modes. They involve the rapid twisting and untwisting of the glass. It is not hard to imagine how the stick-slip of the circular rubbing motion could excite them. But a moment's thought will reveal that they will have negligible impact on the surrounding air, and can therefore be expected to be essentially mute.



ABOVE: Sequential representations of the twisting movement of shear mode S_0, showing one full cycle.
BELOW: Four shear modes.



In principle, higher order combinations such as the one shown at right are possible as well. While probably insignificant in musical glasses, these patterns become more important and have been studied in connection with large bells.



CASSETTES

Notes by Bart Hopkin

Here are more reviews of independently-produced cassettes featuring unusual musical instruments. The reviews are designed to be informative rather than critical; we've simply tried to indicate what is on the tapes and where to get them. Following the short reviews on this page, we have more extended notes on a particularly noteworthy recent release from Soundviews.

VARIOUS ARTISTS:
SOUND SYMPOSIUM 1988 and SOUND SYMPOSIUM 1984

Sound Symposium, 81 Circular Rd., St. John's, Newfoundland, Canada A1C 2Z5.

Sound Symposium is a bi-annual festival of sound and sound arts on the island of St. John's, Newfoundland. These two cassettes contain excerpts from the 1984 and 1988 festivals. Diverse traditional and non-traditional musical styles appear, as well as environmental & nautical sounds. The 1988 tape will be the more interesting of the two for EMI's readers, with sounds from ships' horns, Native American drums & singing, aeolian piano, alphorn, log drums, mouthsounds & extended vocal technique, various electronic and percussion sounds, and church bells. More important than the specific sound sources is the spirit of sonic creativity and respect for diverse cultural sources the tape conveys.

TONY WELLS: COLLAGE and WEATHERSPACE

Karma Productions, 701 Brush St., Las Vegas, NV, 89107.

Tony Wells plays an array of instruments including flutes, singing bowls, chimes, gongs & bells, slit drums, bird whistles, waterphones, and "sculptured percussion." He also incorporates environmental and animal sounds into his music. These two tapes contain spacious, meditative music, presented as a spiritual journey. The instrumental timbres are never obscured by dense textures.

RICHARD GRAHAM: LEXICON

Homeboy Cassettes, 134 Louis St., Brunswick, NJ 08901.

Richard Graham specializes in lesser known instruments of the African diaspora. Included in this recording are congas, berimbaus (Brazilian musical bows), bamboo flute, vaccines (Jamaican or Haitian lip-buzzed bamboo aerophones), balafon, frame drums, cuica, kalimba, diddley bow (a one-string African-American "bottleneck," or slide instrument, in this case struck with a stick in virtuoso solos), plus miscellaneous percussion and electronics. Richard's voice features prominently, showing rap, Brazilian, Pygmy and other influences.

BOB PHILLIPS:
PROXIMITY EFFECT and SILENT ICONS

Bob Phillips, 1315 Dodge Ave., Fort Wayne, IN 46805.

Proximity Effect is a recording of a 1987 radio broadcast presenting music by three Ft. Wayne area composers. Music by Jim Cline and Jay Carrol is primarily electronic; unconventional instruments are not featured prominently (although the artists do achieve some intriguing sounds). Bob Phillips creates pieces in an oddly-muted stop-start style using log drums, homemade flutes, altered electric guitars, and toys (music boxes, rattles, Christmas card keyboard and squeaky toys) all extensively modified electronically.

Silent Icons is an earlier recording by Bob Phillips alone, featuring a wider range of his instruments: mbirimbars, limbaclav, cellophone, kitharmon, electronics and everyday objects. Spacious, textural music in a great diversity of timbres.

VARIOUS ARTISTS:
SOUNDVIEWS, Volume I: SOURCES

Soundviews, 218½ West 4th Ave., Olympia, WA 98501.

This extensive compilation is an important and wide-ranging documentation of current activity in sound-art exploration, so I have singled it out for fuller coverage here.

The Soundviews cassette appeared this spring, after several years in the making. It documents, in short sound excerpts along with some interviews, the work of thirty-six currently active sound artists. Some of those represented are instrument makers; some are sound sculptors and makers of environmental or interactive sound installations; some work with electronics; and some are sound collage artists working with recordings of natural and environmental sound. The cassette comes nicely packaged with a 40-page booklet containing brief notes on each excerpt.

The project developed in connection with a series of broadcasts over radio station KAOS-fm in Olympia, Washington, under the guiding hand of Jeffrey Bartone. "The sounds on this tape," the notes say, "are in all cases excerpts from larger works, environments or processes ... sound often being simply one facet of the experience of a given work. In all these works there is a strong sense of new or enlarged contextuality of sound -- musically, spatially, or socially. Sources is offered in hopes of glimpsing these emerging soundscapes."

This tape frequently focuses on areas of sound exploration that Experimental Musical Instruments explores relatively rarely; in particular, envi-

ronmental sound and sound collage. Let's look at some of the individual selections.

The tape opens with an excerpt from Annea Lockwood's River Archive, which is an extensive compilation of river sounds presented as a study in geography. The sound heard in this selection is that of a human voice: a park ranger working in the Adirondacks along the Hudson river, describing the experience of particular sounds associated with the river -- an everyday, conversational voice inviting us, in a word, to listen.

Next we hear one of Bill and Mary Buchen's large aeolian harps. These strings, far longer than conventional instrument strings, produce masses of clustered overtones, with some pitches standing out more clearly than others. One listens not for melody or harmony but for sound quality, and for the patterns of the wind. The wind harp sound is set off evocatively by crickets chirping.

Bill Fontana's Landscape Sculpture with Foghorns works with the sounds of foghorns on San Francisco Bay. Speakers at the listening site played live broadcasts from microphones set up at eight widespread points on the bay. All of the microphones heard the same booming foghorns, but timing, tone quality and volume was slightly different for each due to the varying distances between different mics and different horns. The broadcast sounds combined with the natural sound of the horns and other ambient sounds at the site. The cumulative effect is not so very strange, but it possesses a certain fullness and spatial richness.

Brass Screen and Bronze Screen are samples from Richard Lerman's Transducer series, which explores the idea of using everyday materials as transducers, converting sound waves in the air into the analogous patterns of electron movement just as microphones do. In this recording we hear the vibrations occurring in small metal screens (as sensed by tiny contact mics, apparently), as they respond to impulses in the surrounding air. The screens are thus functioning like the diaphragms in microphones. The resulting sound turns out to be not unlike what you'd expect in metal screen vibrations.

In Mozart's Moog, Jim Pomeroy presents the sounds of 49 prepared music boxes going simultaneously. Wonderful music!

In Voyager II: Uranus FlyBy, Dr. Frederic Scarf gives us a recording of radiation emitting from space, by converting the electromagnetic radiation from space into analogous waves in the air within the audible frequency range. The sound is a little like an electronic wind.

David Behrman and George Lewis' Installation for Parc de La Villette has as its central element a kalimba, set out to be played by visitors to the site. A set of sensors on the instrument are linked to a computer system which controls both a graphics display and a synthesizer. The synth and graphics screen respond to the human player's musical figures with related patterns of their own generated by a special program. The music is lovely; successful simply because the chosen synthesizer timbres work nicely with the natural kalimba tones, and the note patterns that arise, with their mix of programmed and human elements, are musical and appealing.

Speaker Swinging is Gordon Monahan's work in which three or more performers swing speakers on long wires in huge circles, as the speakers play sine tones or other synthesized drones. Doppler effects, directional effects, and acoustic interference effects between the speakers enrich what would otherwise be simple drones.

Extrait d'Resurgence, by Bernard Baschet, Michel Deneuve & Alain Dumont, is a performance on several Baschet instruments, which include (judging tentatively by the sound), some metal friction rod instruments and a wobbly-pitch string instrument, in a single droning but appealingly varied and moving chord.

Jeffrey Bartone's Sky Concert is a recording of a concert consisting of radio receivers located on roofs across a ¼ mile area, playing tape music and environmental sound broadcast by KAOS-fm radio. On this (the Soundviews tape) recording, sounds from the locations where the speakers were placed are heard as well. Within the collage we hear pan music, water sounds, kids playing and adults conversing, applause, a glass harmonica, and a boiler-room fireman at a brewery, discussing the importance in his work of attention to sounds associated with the operation of the plant.

In No More Fear, with Pauline Oliveros, Linda Montano, Tom Jaremba and children, a group of youngsters provide sound accompaniment and character voices for a story. The sound of the children's voices is like some irresistible snapshot of kids at play, only better.

Factory Whistle Carols is an old, scratchy recording of an anonymous worker in Pittsburg playing Christmas carols at great volume on a sliding steam-operated factory whistle.

On one level, some of the sounds on this tape eventually become uninteresting, especially if the listener doesn't make the effort to explore each piece diligently both for purely aural content and for emotional meaning. This is particularly true for noisy (i.e., lacking meaningful frequency relationships) droning sounds, cheap electronics or things using not-so-great contact mics, and anything recorded on a boombox with an internal microphone. But there is a lot of material here. Most of it is diverse, interesting and enjoyable to listen too. Also most of it is intellectually challenging -- there are so many ways to create sound and so many ways to listen! -- and much of it is rich in human emotional meaning, or satisfying simply as music.

Also included on this tape but not mentioned above are: Karen McPherson's ambient nature sounds, Julius' little-speaker electronic bird sounds, Hildegard Westerkamp's urban environment sounds, Andrej Zdravic's cicada music, Harry Bertoia's metal rod sculptures, Doug Hollis' large aeolian pipes, Robin James' passing train, a carillon concert, Paul Panhuysen & Johan Goedhart's long string installations, Lief Brush's Teleconstructs, Ron Konzak's Puget Sound Wind Harp, Bart Hopkin's Disorderly Tumbling Forth, Susan Stone's radio work, a John Cage interview, Robert Rutman's Steel Cello, a speech piece by Ellen Zweig, Peter Richards' Wave Organ, and Paul DeMarinis & David Behrman's interactive music and video game called Sound Fountain.

A COMPARATIVE TUNINGS CHART

Experimental Musical Instruments thanks the many people who helped in the creation of this chart and accompanying notes, including writers, proof-readers and referees, as well as composers & theoreticians who have allowed their work to appear.

In EMI's February 1989 issue we published a sound spectrum chart, laying out values for frequency, pitch name and wavelength, over the entire audible range. We follow now with another approach to mapping the sonic continuum. What we present this time is a comparative chart of tuning systems, showing how pitch sets from various sources compare to the most basic just intervals, to the familiar 12-tone equal temperament scale system, and to one another. Tunings from diverse music cultures, historical European scale systems, and scales created by contemporary composers and theorists are represented on the chart.

PRELIMINARY NOTES

To make sense of the chart, anyone who has not already done so should abandon the idea that there are exactly twelve possible tones per octave. There are twelve tones per octave on the piano and most other western instruments, but there is an infinity of possible tonal gradations between any two piano notes, and our ears are capable of hearing far finer pitch distinctions than 12-per-octave calls for. As the chart shows, different people at different times have approached the division of the octave's tonal continuum in many different ways, and continue to do so.

A tuning, as we're using the word here, is a set of pitches available, by convention, for use in a given musical style or tradition. The word may imply a set of absolute pitches -- that is, a specific set of frequencies, as when in western tradition one speaks of a C Major scale -- or it may be meant to indicate only a set of relative interval relationships, as when one simply speaks of a major scale without specifying a key. In the latter case, the tuning retains its identity as long as its relative pitch relationships are retained, no matter how it might be transposed from one absolute pitch level to another.

In the chart given here, all is relative. For comparative purposes, all the tuning systems are built over a common, unspecified fundamental. Relative pitch relationships can be seen, but no specific frequencies are given.

READING THE CHART

Here is how things are laid out on the chart. Each tuning appears in the familiar vertical ladder arrangement, starting at the bottom of the page, with the ascending pitches spaced out above according to the sizes of the intervals within the set of pitches. Vertical distances are calibrated for uniform interval size, so that a given interval always corresponds to the same vertical distance; e.g., 1.8 cm in vertical distance represents an equally tempered semitone.[1] Each tunings is given over a range of one octave or a bit more.[2] To help demark the tonal territory, horizontal reference lines cross the entire chart at heights corresponding to certain basic just intervals: the major second 9:8, the major third 5:4, the perfect fourth 4:3, the perfect fifth 3:2, and the major 6th 5:3.

The degrees of each scale are indicated by short bold horizontal marks, except for ambiguous or variable scale degrees, which are represented by dappled areas of varying density. Below the mark, where applicable, is a name or number for the particular degree of the scale. To the right of the mark a cents value appears, and to the left will be seen a ratio or decimal number. Both the cents value and the ratio or decimal are given in relation to the first degree of the pitch set. (The three Javanese tunings are handled slightly differently; for full information, see the notes below on those tunings.)

Let's review the meaning of the relative pitch indicators just mentioned.

IDENTIFYING INTERVALS BY RATIOS: JUST INTONATION

Musical intervals can be described as ratios of rates of vibration. For example, we hear the interval of an octave between two pitches whose vibrational frequencies have the ratio 2:1, meaning that one tone is vibrating at twice as many cycles per second as the other. It matters not what the two frequencies actually are; as long as they form a 2:1 ratio, we will hear the octave. Similarly, 3:2 corresponds to the interval of a fifth, 5:3 to a major 6th, and so forth. The ratios appearing on the chart give the frequency of the given scale degree over the frequency of the starting tone of the tuning, reduced to the simplest terms.

The idea of expressing intervals as ratios forms the basis of just intonation theory. Tunings and intervals that are expressible in these terms can be called just.

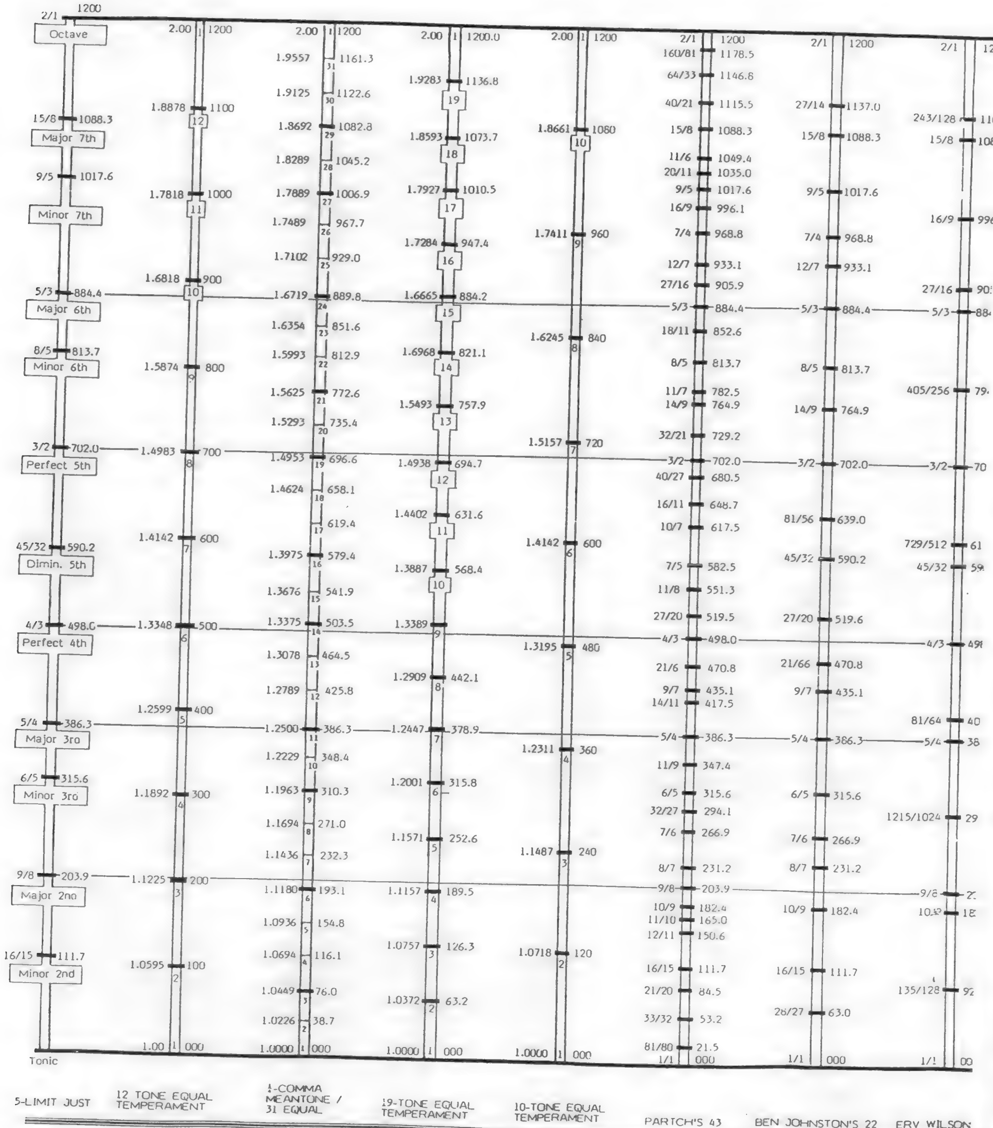
IDENTIFYING INTERVALS BY DECIMALS: TEMPERED SCALES

European tunings are generally said to be based, in the ideal, in simple just intervals. But over the last couple of centuries European musicians have seen fit, in tuning their instruments, to slightly detune, or "temper", those intervals. This is done to create scales in which interval sizes are more uniform than they would be in a pure just system. There are certain practical advantages to this.

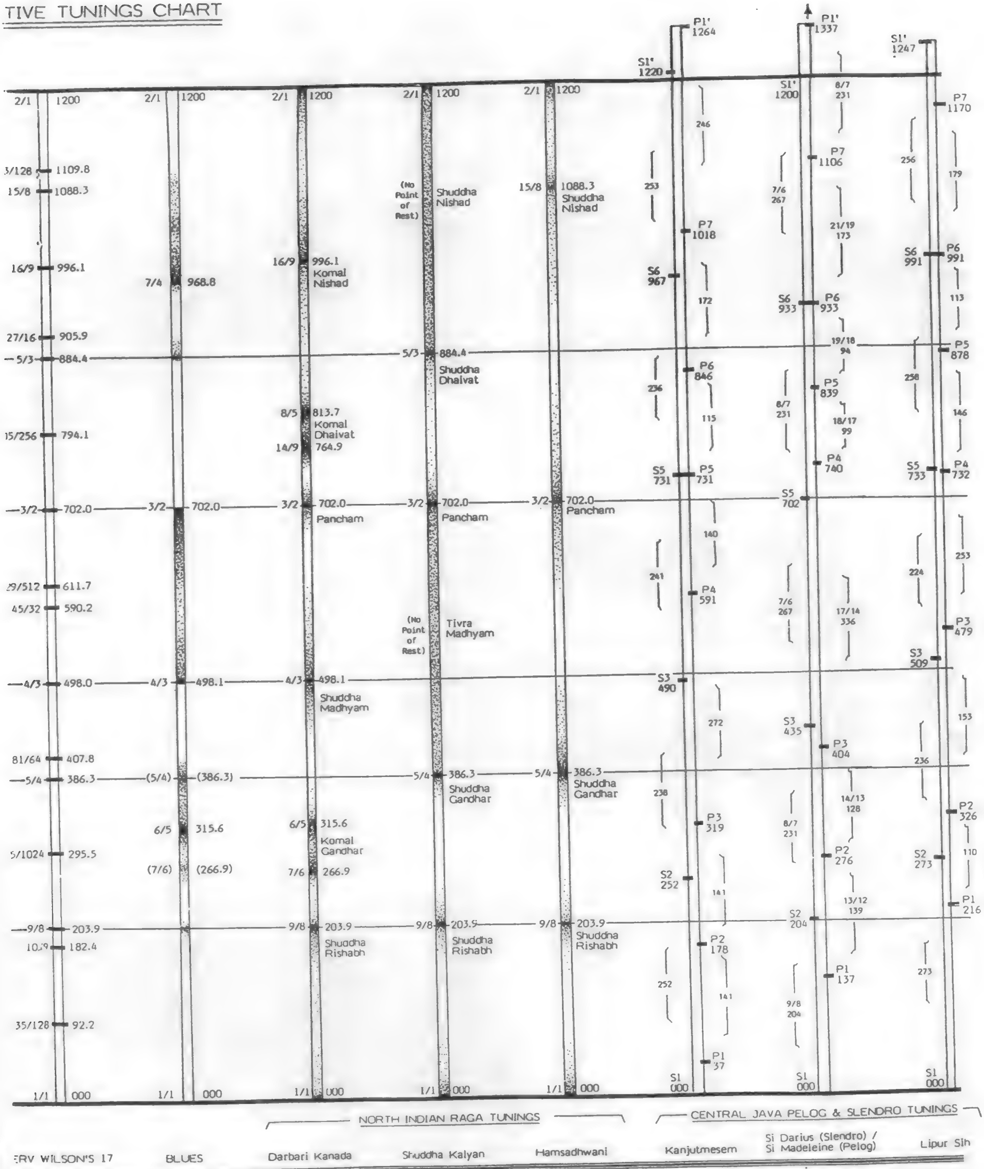
To create tempered scales, a different sort of mathematic is called for. Ratios are out. A

1. Calibrating for uniform interval size in this way means that increments in frequency are not uniformly spaced arithmetically, but logarithmically. This makes sense from the ear's point of view.

2. The one octave range is adequate if you assume that the same set of intervals would in practice be duplicated in other octaves. That's not true of all tuning systems, and for that reason the range is exceeded on some tunings given here.


2/1 1200 Octave
15/8 1088.3 Major 7th
9/5 1017.6 Minor 7th
5/3 884.4 Major 6th
8/5 813.7 Minor 6th
3/2 702.0 Perfect 5th
45/32 590.2 Dimin. 5th
4/3 498.0 Perfect 4th
5/4 386.3 Major 3rd
6/5 315.6 Minor 3rd
9/8 203.9 Major 2nd
16/15 111.7 Minor 2nd
Tonic
5-LIMIT JUST
2.00 1 1200
1.8878 1100 12
1.7818 1000 11
1.6818 900 10
1.5874 800 9
1.4983 700 8
1.4142 600 7
1.3348 500 6
1.2599 400 5
1.1892 300 4
1.1225 200 3
1.0595 100 2
1.00 1 000
12 TONE EQUAL TEMPERAMENT
2.00 1 1200
1.9557 31 1161.3
1.9125 30 1122.6
1.8692 29 1082.8
1.8289 28 1045.2
1.7889 27 1006.9
1.7489 26 967.7
1.7102 25 929.0
1.6719 24 889.8
1.6354 23 851.6
1.5993 22 812.9
1.5625 21 772.6
1.5293 20 735.4
1.4953 19 696.6
1.4624 18 658.1
17 619.4
1.3975 16 579.4
1.3676 15 541.9
1.3375 14 503.5
1.3078 13 464.5
1.2789 12 425.8
1.2500 11 386.3
1.2229 10 348.4
1.1963 9 310.3
1.1694 8 271.0
1.1436 7 232.3
1.1180 6 193.1
1.0936 5 154.8
1.0694 4 116.1
1.0449 3 76.0
1.0226 2 38.7
1.0000 1 000
¼-COMMA MEANTONE / 31 EQUAL
2.00 1 1200.0
1.9283 1136.8 19
1.8593 1073.7 18
1.7927 1010.5 17
1.7284 947.4 16
1.6665 884.2 15
1.6968 821.1 14
1.5493 757.9 13
1.4938 694.7 12
1.4402 631.6 11
1.3887 568.4 10
1.3389 9
1.2909 442.1 8
1.2447 378.9 7
1.2001 315.8 6
1.1571 252.6 5
1.1157 189.5 4
1.0757 126.3 3
1.0372 63.2 2
1.0000 1 000
19-TONE EQUAL TEMPERAMENT
2.00 1 1200
1.8661 1080 10
1.7411 960 9
1.6245 840 8
1.5157 720 7
1.4142 600 6
1.3195 480 5
1.2311 360 4
1.1487 240 3
1.0718 120 2
1.0000 1 000
10-TONE EQUAL TEMPERAMENT
2/1 1200
160/81 1178.5
64/33 1146.8
40/21 1115.5
15/8 1088.3
11/6 1049.4
20/11 1035.0
9/5 1017.6
16/9 996.1
7/4 968.8
12/7 933.1
27/16 905.9
5/3 884.4
18/11 852.6
8/5 813.7
11/7 782.5
14/9 764.9
32/21 729.2
3/2 702.0
40/27 680.5
16/11 648.7
10/7 617.5
7/5 582.5
11/8 551.3
27/20 519.5
4/3 498.0
21/6 470.8
9/7 435.1
14/11 417.5
5/4 386.3
11/9 347.4
6/5 315.6
32/27 294.1
7/6 266.9
8/7 231.2
9/8 203.9
10/9 182.4
11/10 165.0
12/11 150.6
16/15 111.7
21/20 84.5
33/32 53.2
81/80 21.5
1/1 000
PARTCH'S 43
2/1 1200
27/14 1137.0
15/8 1088.3
9/5 1017.6
7/4 968.8
12/7 933.1
5/3 884.4
8/5 813.7
14/9 764.9
3/2 702.0
81/56 639.0
45/32 590.2
27/20 519.6
21/66 470.8
9/7 435.1
5/4 386.3
6/5 315.6
7/6 266.9
8/7 231.2
10/9 182.4
16/15 111.7
28/27 63.0
1/1 000
BEN JOHNSTON'S 22
2/1 12(
243/128 11(
15/8 108
16/9 99
27/16 90
5/3 88
405/256 79
3/2 70
729/512 61
45/32 59
4/3 49
81/64 40
5/4 38
1215/1024 29
9/8 2
10/9 18
135/128 92
1/1 00
ERV WILSON

TIVE TUNINGS CHART



logarithmic approach is in.[3] Alongside each degree of the tempered scales on this chart, where the ratios appeared for the just scales, you will see a decimal number between 1 and 2. Like the ratios, the decimal is the number by which the frequency of the first degree must be multiplied to give the frequency of the degree in question.[4] The decimals are, like the ratios, a way of expressing an interval.

THE CENTS SYSTEM FOR MEASURING MUSICAL INTERVALS

One of the primary methods for precise measurement of musical intervals uses the unit called the cent, defined as 1/100th of a semitone in 12 tone equal temperament. The octave thus comprises 1200 cents. Aside from being useful in its own right as a calibrator, this cents value provides a quick and easy comparison to nearby pitches in 12 equal. For example, you can quickly recognize that a tone in some exotic tuning standing at 270 cents above the tonic is 30 cents (3/10 of a semitone) below the minor third in 12-equal, since by definition the 12-equal minor third is 300 cents.

WORTH BEARING IN MIND: DESCRIPTIVE VS PRESCRIPTIVE TUNINGS

Tunings can be determined either descriptively or prescriptively. Tuning information is descriptive when it amounts to description of existing musical practice: someone observes a musical tradition, analyzes the music to determine what pitches are being used, and lines them up in ascending order to create a scale. Tuning information is prescriptive when it is designed not to describe what someone has done, but to tell someone what to do, as when a musician devises a tuning for a particular musical purpose and then proceeds to use it. This chart contains both prescriptive scales -- deliberately created by composers or theorists for one reason or another -- and descriptive scales, representing existing musical practice in various cultures. Prescriptive scales are theoretical in nature, and can usually be neatly presented in black and white. Descriptive scales inevitably entail more difficulties. Intonation in actual musical practice generally turns out to be subtle and highly nuanced, and not easily pinned down with accuracy and confidence. It may vary from moment to moment and musician to musician. For this reason, we have included more extensive notes on two of the traditions presented here -- the Indian and the Indonesian -- written by musicians and scholars with extensive experience in the areas.

WHAT DO ALL THESE TUNINGS SOUND LIKE?

Are there ways you can actually hear these tunings? Different readers will have different resources available to them, and those with computers and software set up for this kind of thing have a great advantage. But for the rest of us, the easiest approach might be to construct a monochord, or perhaps a harmonic canon (which can be thought of as a many-stringed monochord zither). The scale degree ratios or decimals correspond inversely to string lengths, and so it is not difficult to calibrate a rule alongside or beneath the string(s) and mark the string stopping points for the relevant pitches. Alternatively, those with digital tuners (which are getting less expensive all the time, and which usually have VU meters calibrated in cents) can work from the cents values on the chart to tune zithers, metal conduit marimbas (often called tubulongs), or any other easily made instruments of dependable pitch.

You can also hear many of these tunings in recordings. Recorded music in diverse just scales can be had from the Just Intonation Store of the Just Intonation Network (535 Stevenson, San Francisco, CA 94103; (415) 864-8123). Recordings of higher order equal temperaments have been produced by Ivor Darreg (3612 Polk Ave., San Diego, CA 92104) and Buzz Kimball (RFD 1 Box 91, Contoocook, NH 03229). Recordings of music in non-western scales are widely available from stores and distributors specializing in such things. To hear music in 12-tone equal temperament, turn on the radio.

THE TUNINGS

5-limit Just

5-limit just intonation is normally considered to be the theoretically ideal intonational basis for music in the European tradition, and some other music traditions as well. The designation "5-limit" refers to the fact that 5 is the largest prime number required in either numerators or denominators to build the ratios of the tuning (Roughly speaking, the larger the limit number, the more harmonically complex and potentially dissonant will the intervals of the tuning be perceived.) Although this scale has 12 tones per octave, nominally analogous to those of standard 12-tone equal temperament, it functions quite differently, since it includes only those tones needed to play in a few closely related keys. The sound or mood of an accurately-tuned 5-limit is usually described as profoundly sweet and restful. A common form of 5-limit is presented here; other variations are possible.

12-Tone Equal Temperament

12-ET, dividing the octave into 12 equal steps, is the standard tuning in current western music; it is what we hear every day and it is what has been taught as correct in mainstream practice for a couple of centuries now. 12-ET has found favor over other ETs (equally spaced divisions of the octave with different numbers of steps) because it manages to do a fairly good job of approximating the intervals of five-limit just -- i.e., it happens to have intervals reasonably close to the important 5-limit intervals. Other ETs that do comparably well in this regard have inconveniently large numbers of tones per octave.

Quarter-Comma Meantone / 31 tone Equal Temperament

Quarter-comma meantone, an unequal temperament,

3. For more on the mathematical basis of equal tempered scales, see Christopher Banta's "Scales and their Mathematical Factors" in EMI Volume I #5, February 1986.

4. These decimals in most cases are irrational numbers, extending infinitely to the right of the decimal point. On the chart they are rounded off to 5 significant digits.

was one of the widely-used temperaments prior to the ascendance of 12-equal in the 18th century. The early unequal temperaments sought to achieve excellent approximations of just intervals in some keys, at the cost of very poor approximations in some other keys (which were then avoided). Meantone temperaments were designed to produce good 3rds and 6ths (which are the poorest intervals in 12-equal) in the chosen keys. Quarter-comma meantone is generated by adding series of fifths, slightly detuned such that a series of four such fifths will add up to two octaves plus a flawless just major 3rd. Continuing around the cycle (with octave displacements) until the fifth has been added eleven times completes the scale.

It happens that if, instead of stopping after eleven, you continue the cycle of additions of the same fifth, you come very close to duplicating your original starting tone after 31 additions. In doing so, you have effectively generated a 31-tone equal temperament. Thus, quarter comma meantone can be considered, with just a little fudging, to be a subset of 31-tone equal temperament. Accordingly, 31 ET and Quarter-Comma Meantone are presented on a single axis on the chart here.

The cents values and scale degree multipiers given are correct for 31-equal except on the twelve meantone degrees, where the correct meantone values are given. The two differ by no more than a little over a cent, or about .0005 for the multipliers.

More Equal Temperaments: 10 and 19

19-tone equal temperament has been cited as a practical short-term option for moving to higher order ETs, since it approximates important just intervals nicely, and could be accommodated using keyboard layouts and notational systems based in the familiar forms used for 12-equal.

10-tone equal temperament is included here for opposite reasons: it's an example of a blatantly noncomformist tonality. There are no intervals comfortably close to normal 3rds, 4ths or 5ths; in short, the listener is deprived of familiar touch-points, and the tonality must simply be heard on its own pungent terms. For more on 10-Equal, see Gary Morrison's article in **Interval**, Vol. II #1, Fall 1979 (PO Box 8027, San Diego, CA 92102.

Monophonic Fabric (Partch's 43)

Harry Partch, whose just intonation work from the 1940s to the 60s proves more prophetic with each passing day, set forth this 11-limit scale as his most comprehensive tonal resource. For some of the reasoning behind his choice of intervals, and for some insight into one of our century's exceptional minds (and a serious instrument maker as well), read Partch's **Genesis of a Music** (New York: Da Capo Press, 1979).

Ben Johnston's 22-Tone Microtonal

This is one of several scales appearing in the chart which were prescriptively devised by a contemporary composer for specific musical purposes. Ben Johnston writes, "It is the chromatic scale in a system using prime numbers 2, 3, 5 and 7 to generate its ratios. It results from combining major and minor scales generated using rules derived from the traditional Pythagorean 7-tone diatonic scale. It was used in my **String Quartet No. 4 (Amazing Grace)** as the basis of the closing section, and its proportions also govern rhythmic subdivisions in some parts of that work. Cf. Randall Shinn's "Ben Johnston's String Quartet No. 4," **Perspectives of New Music**. The scale derivation is discussed in **Rational Structure in Music**, reprinted in **1/1**."

Erv Wilson's Just 17-Tone Genus

Erv Wilson writes:

"A chain of diatonic tetrachords (16/15, 9/8, 10/9), repeated seven times, is the origin of this 17-tone scale. This corresponds to a chain of alternating major thirds (5/4) and minor thirds (6/5). A synthesis of tetrachordal melody and triadic harmony is thus achieved. This is similar to a 13th century Persian scale tuned as a chain of fourths (4/3)."

For more on this scale, see Erv Wilson's **Some Basic Patterns Underlying Genus 12 & 17** (844 N. Ave. 65, Los Angeles, CA 90042).

Blues

Blues is surely one of the most exotic, subtle, complex, rich and beautiful approaches to intonation imaginable. It has provided a major counterbalance to the predominance of 12-equal in European and American music of this century. Blue tonalities, of course, are highly flexible and ambiguous. They make extensive use of sliding pitches; minute intonational inflections have musical meaning. Blues has a peculiar veiled quality in which pitches can be hinted at without actually being sounded, or seemingly reached for in such a way that the reaching, rather than the reached-for, becomes the musically significant thing.

To represent all this graphically would be impossible. On the chart the blue tonalities appear, inevitably, primarily as a series of gradations.

North Indian Ragas

Notes by David Courtney, Ph.D.

The discussion that follows is relevant only to the North Indian musical system. This system, known as Hindustani Sangeet, is the system that most Americans are familiar with. There is another system called Carnatic Sangeet, for which the information given here does not apply.

Debate as to the exact intervals used in Indian ragas has been going on for at least half a century. I do not claim to be the final word on the subject. Indeed, variations from one performer to the next may actually preclude the possibility of a resolution.

The method for determining the musical intervals appearing on the chart was quite simple. I have been working with a computer program which allows me to specify musical intervals from a table in the software. This approach allowed me to program small compositions in the various ragas (modal forms) and manipulate the intonation. These variations were then evaluated by Indian musicians. It was then possible to fine tune the tables to the required values. The initial values

for the table came from two sources: Standard ratios derived from Helmholtz, and some very fine theoretical work by Dr. Jayant Kirtani. The conclusions of both Helmholtz and Kirtani were basically in agreement and validated by the computer experiment. However, a few minor points relevant to the raga required modification.

Raga (or Rag) is an aesthetic concept embodying both musical and non-musical components. For the present purposes, however, I will confine my discussion to modality, because this is the area where intonation has the greatest significance.

A raga may be composed of 5, 6 or 7 notes. These notes are derived from a 12 note scale much as western scales are derived from the 12 note chromatic scale. The augmented fourth (tiura madhyam) has been subject to considerable variation. The value of 53/37 was derived entirely theoretically by Dr. Kirtani. I have placed this value in my computer and have found it to be most acceptable.

It must be pointed out that these values do not have the same significance as they would in a western system. The reason is that these "notes" are not considered discrete building blocks for the music. In practice, the entire tonal continuum is used, and the specific pitches indicated here are simply considered convenient resting places. This totally microtonal approach to the music produces some very interesting variations in the utilization of the pitches. The concept of "notes" being mere resting points has some interesting twists to it. There appear to be three possible ways of regarding a given "note." In the simplest approach, a single pitch serves as the resting point. This approach is illustrated in the chart under Rag **Hamsadhwani**. It is also possible to have notes in the rag which do not have any resting point at all. This is demonstrated by the Shuddha Nishad (major 7th) and the Tivra Madhyam (augmented 4th) of Rag **Shuddha Kalyan**. These notes exist only in the form of an elongated slide from Sa (octave) down to the Dhavat (major 6th) and another slide from Pancham (5th) down to the Gandhar (major 3rd). Another concept is to have oscillating resting points. This is illustrated by the two values for Komal Dhaivat (minor 6th) in **Darbari Kanada**. This approach is characterized by alternating between the two values in a slow shake or vibrato.

Even the supposedly "simple" resting point turns out to be not quite so simple. As described earlier, the "resting point" concept presupposes that the pitch can "wander" around. If such a process were random we could expect to see what is referred to as a normal distribution. In reality, however, it is common to see a skew in the distribution around the stated values. The most common examples are the use of Shuddha Nishad (major 7th) and the Komal Rishabh (minor 2nd). It is a very common practice to raise the Shuddha Nishad in ascending passages and to flatten the Komal Rishabh in descending passages. Other notes may also show a skew, but these these tend to display themselves only in particular ragas.

Data for three Indian scales appear on the chart: Darbari Kanada, Shuddha Kalyan, and Hamsadhwani. Many many more ragas exist. Remember that what is presented here is only pitch information, which is only a skeleton; each raga has many other associated musical and extra-musical qualities.

Pelog & Slendro

The gamelan ensemble of Central Java often takes the form of twin instrument sets tuned to two different sets of pitches. The two tunings, called slendro and pelog, are not universally fixed, but vary, within limits, from gamelan to gamelan. Tunings from three different gamelan appear on the chart. The data was gathered by Larry Polansky, who has provided the following comments.

NOTES ON THE TUNINGS OF THREE
CENTRAL JAVANESE SLENDRO/PELOG PAIRS

by Larry Polansky

In the accompanying chart, three slendro/pelog pairs are given. The first is the measurement of the famous slendro/pelog gamelan at the Mangkunegaran Palace in Solo, Central Java, called Kanjutmesem. The second is the tuning for Lou Harrison and Bill Colvig's gamelan Si Darius/Si Madeleine, an aluminum gamelan built at Mills College. The third is my own measurement of the pelog/slendro pair of the two slenthem (a large, resonated bronze mallet instrument) in gamelan Lipur Sih, built and tuned by Tentrem Sarwanto of Semanggi, Solo, Central Java, and owned by myself and Jody Diamond.

In my notation for these tunings, I have started each pair on slendro 1 (S1), but not because this is an any way a "root," tonic, or fundamental. There is nothing to suggest that S1 is any more primary than other notes in slendro. Pitches are labelled simply as S1-S6, P1-P7, with S1' and P1' denoting a higher octave of that degree. The absolute cents intervals from S1 are written next to the pitch name, and the cents interval to adjacent pitches is written between the pitches.

I have included these three pairs of slendro/pelog because I am interested in the ways that the two gamut relate, a subject which has not received as much attention as the absolute interval widths of each individual gamut. I hope that these simple graphs will give the reader some idea of the complex system of tuning in Central Javanese "double" gamelan.

Some notes on the slendro/pelog pairs described here:

1) These tunings, including the Harrison/Colvig gamelan, represent intonational ideas from Central Javanese pelog and slendro in the court gamelan tradition. Quite different tunings will be found in villages, other ensembles (like street Siteran and so on), and other parts of Indonesia (Bali, Sunda, East Java, Cirebon, etc.).

2) Certain important aspects of Central Javanese tuning practice are not fully represented in these charts, notably: stretched octaves (generally 10-20 cents), the wide variation in interval size in different gamelan, the relationships of tuning to pathet (mode), and the variation in tuning when different tumbuk (a note that is the same in slendro and pelog) are used. Note that two out of the three gamelan described here are tumbuk 6 (meaning that slendro 6 is equal to pelog 6). Tumbuk 6, 5, and to a lesser extent, tumbuk 2, are the most common tumbuk. These ideas, and others,

deserve discussion at length, but are beyond the scope of these brief notes.

3) A common theoretical model for gamelan tunings is the Idealized ET Tuning, which presents slendro as 5-tone equal, and pelog as a subset of 9-tone equal. For tumbuk 6, the pitches in ascending sequence would be:

S1 (nominally at 0 cents), P1 (160¢),
S2 (240¢), P2 (293.3¢), S3 (480¢),
P3 (560¢), P4 (693.3¢), S5 (720¢),
P5 (826.6¢), S6/P6 (960¢), P7 (1093.3¢),
S1' (1200¢), P1' (1360¢).

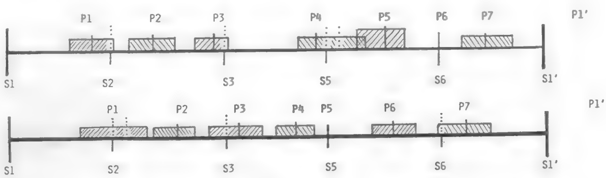
This model is useful and appears frequently in the writings of both western and Javanese theorists. In James Tenney's recent work, The Road to Ubud, for prepared piano and gamelan, the piano is tuned to a pelog based on 9-tone equal. As far as I know no gamelan has ever been tuned exactly this way.

4) The measurements for Kanjutmesem are taken from an important article by Surjodiningrat, Sudarjana and Susanto, of Gadjah Mada University, in Jogjakarta (1972) entitled "Tone Measurements of Outstanding Javanese Gamelans in Jogjakarta and Surakarta." I have used their spelling for the name of the gamelan (rather than the more modern Kanyutmesem). Their measurements, which correct some important flaws in Kunst's earlier measurements (Music in Java, Volume II, edited by E.L. Heins, The Hague, Martinus Nijhoff, 1973, 3rd edition) are in hertz. There is a 1 hz. difference between S5 and P5 here that I have "rounded off" for simplicity and my interest in showing a tumbuk, but the reader is advised that whether a "real" tumbuk is perceived in this tuning is open to question. In the computations of cents values from the actual frequencies measured, I have rounded off to the nearest cent. This gamelan tuning is included because it is one of the most recorded gamelan in the world, and has been influential in the study of classical Central Javanese gamelan in the west. Its current tuning is significantly different than the one measured by these authors in 1972, since it has been "renumbered." Kanjutmesem, like Lipur Sih, has significantly stretched octaves, so that, for example, P1 is not a 2/1 to P1'. Note also the unusually wide (for measured Central Javanese tunings) P3-P4 interval -- likely the result of a renumbering in the past, meaning that this interval appeared between two different pelog tones at an earlier time. But, as Carter Scholz has pointed out, this interval (P3-P4) is smaller than two steps of 9-tone equal, and considerably smaller than Si Madeleine's 336¢. The slendro is remarkably close to the much maligned 5-tone equal model of slendro.

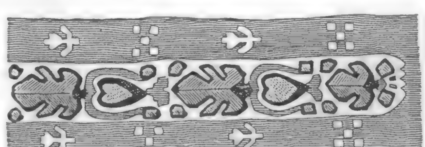
5) Lou Harrison and William Colvig have built several gamelan, each with a different tuning. The Si Darius/Si Madeleine tuning, I believe, represents a fairly early model of Harrison's just intonation interpretation of slendro and pelog, and is influenced by, but not a copy of, the tuning of gamelan Kyai Udan Mas (a tumbuk 6 gamelan which has been in residence and the University of California at Berkeley since 1976). Harrison's more recent tunings have avoided the perfect 3/2 fifth of these earlier tunings, and he is now working with stretched octaves as well. However, this pair is an important model for the study of American tuning systems in gamelan, and it is interesting to compare it to some actual Javanese tunings. Joan Bell Cowan's M.A. thesis from Mills College, "Gamelan Range of Light: The Influence of Instrument Building in Composition" (1985), presents Harrison's tuning in comparison with two other American tunings for aluminum gamelan, her own Range of Light and Daniel Schmidt's Berkeley Gamelan.

6) The tuning for the slendro/pelog pair of gamelan Lipur Sih was measured within a few days of its construction and first tuning (in December, 1988), using some tuning measurement and analysis software I wrote for the Amiga computer using the computer music language HMSL. For these measurements, the steady-state (middle) section of the tone was used. There is usually no low 6 or high 1 (P1') on a pelog slenthem, and the low 6 of the slendro slenthem, not given in the table, is 234 cents below the low S1.

7) It is interesting to compare this data with two "charts." These are constructed from descriptions and drawings made by Tentrem Sarwanto as an explanation of the possible archetypes of relationships between pelog and slendro. The first chart is the possible and common relationships between slendro/pelog pairs with tumbuk 6, and the second of those with tumbuk 5. These two charts are quite general as intervals may vary significantly, and pelog/slendro relationships are not consistent from gamelan to gamelan, even with the same tumbuk. In this chart I have tried to show: the range that each pelog interval may assume in relation to a given slendro interval; the "most likely" value that each pelog interval might assume in general proximity to its slendro neighbor (indicated by a heavy vertical line); and possible equivalences between slendro and pelog, besides the tumbuk itself (indicated by a dotted line). For example, with a tumbuk 6, slendro 5 can usually replace pelog 4 "in a pinch" (which is economically more feasible in the case of the larger bronze instruments: it means that only ten pitches are needed instead of eleven!). Other equivalences are possible and common, such as the near equality of slendro and pelog three in Lipur Sih. I have described these pairs in terms of the relationship of pelog to slendro because I believe that slendro is most often tuned first, and pelog is "fitted" to the slendro. While this is not always the case, there is theoretical and empirical evidence that this is a common occurrence.



ABOVE: Tentrem Sarwanto's generalized chart showing possible relationships between pelog and slendro, with tumbuk 6 (top) and tumbuk 5 (bottom).



ENCYCLOPEDIA OF AUTOMATIC MUSICAL INSTRUMENTS

by Q. David Bowers

Published in 1987 by The Vestal Press (320 N. Jenson Rd., PO Box 97, Vestal, NY 13850).

THOSE MAGNIFICENT MUSIC MACHINES

LP recording of automatic instruments, from the collection of Doyle H. Lane

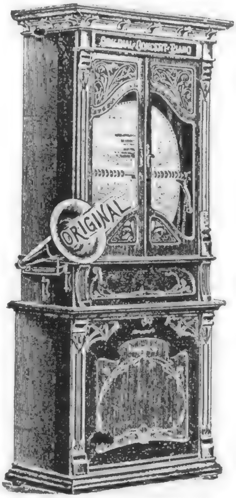
Manufactured by Ensemble Productions Ltd. (for Vestal Press?); distributed by The Vestal Press (address above).

THE STORY OF THE VIOLANO-VIRTUOSO WORLD'S ONLY SELF-PLAYING VIOLIN & PIANO

No author credited

Promotional brochure produced by the Mills Novelty Company sometime after 1910; reprinted and distributed by The Vestal Press (address above).

Reviewed by Bart Hopkin



The Lochman Original Concert-Piano with Phonograph, a German-made disk-operated piano machine with built-in phonograph, circa 1903. This and other depictions appearing in this article are from manufacturers' promotional materials reproduced in David Bowers' Encyclopedia of Automatic Musical Instruments.

Our topic today is mechanical musical instruments of yesteryear, as represented by a set of three selected publications -- or, more specifically, two printed works and a recording. All three come from The Vestal Press, which was featured in EMI in August, 1988. The Vestal Press is assuredly the most kid-in-a-candy-store complete outlet for materials on old time mechanical instruments, as well as a host of similar subjects. The items chosen for review here represent three different approaches to the topic: we have an extensively-researched contemporary written work, a reprint of an early promotional pamphlet, and a recording of surviving, painstakingly restored instruments.

In their hey day, really not so long ago, mechanical instruments had a role to play in everyday musical life. In the decades before the appearance of electronic sound reproduction, and for quite some time after as well, mechanical instruments of one sort or another were one of the major sources of listening pleasure for millions of people. Huge, ornate, mechanically complex orchestrions stood in the homes of the very very wealthy. A broader section of the upper class could afford fine reproducing pianos, while many in the middle classes had simpler player pianos. Those without means to put such things in their livingrooms heard popular tunes rendered by a bewildering array of mechanical contraptions in dance halls and juke joints across the land; and many an itinerant busker turned a few pennies as he turned the crank of a barrel organ. It's easy now to forget or to overlook not only how widespread such instruments once were, but also how much fun they could be -- or how clever, how beautiful, how extravagant, how sweet, how silly, how outrageous.

Did I hear someone, during the above recitation, "What's an orchestrion?" Or did anyone happen to ask "What's the difference between a reproducing piano and a player piano?"

The term orchestrion has been used loosely to refer to any number of mechanical devices playing more than one basic instrument type. But its primary association is with the most elaborate of these -- mechanical assemblies designed to play eight or ten or more instruments types, set in one big casing and sold as a unit. Several manufacturers in the United States and Europe produced such things. They often had piano-like sets of hammered strings, ranks of organ pipes including reed and flue pipes of diverse imitative voicings, banjos and mandolins, drums with and without snares and in various sizes, bells, glockenspiels and wooden xylophones, and innumerable other tricks. They were capable of playing an expandable number of arrangements from the popular and classical repertoires, often modelled after orchestral scores, quite full and complex. The arrangements were programmed and the mechanisms activated by pinned cylinders -- enlarged versions of those seen in little Swiss wind-up music boxes -- or by metal disks with functionally similar small protrusions, or by perforated paper rolls in one configuration or another, similar to those used in player pianos. In most cases these mechanical information storage systems did not control the sounding elements directly, but operated the valves of a Byzantine pneumatic network which in turn activated mechanical playing movements. In spite of the fascination with mechanization manifest in these things, the sound sources themselves could in many cases have been snatched directly from human players: through the glass

cabinet fronts you can see the familiar shape of a violin being played by a mechanical bow, every day banjos plucked by mechanical fingers, accordions bought off the shelf and squeezed by mechanical arms.

I've given this rough description of the fancy orchestrions, because it provides some sense of the sorts of things we are dealing with in the reviews that follow. Smaller mechanical instruments of the era, despite their endless mutation and proliferation, usually followed similar, if simpler, approaches.

And as to our other question concerning the difference between a reproducing piano and a player piano: both of these instruments amount to pianos which incorporate a system for programmed mechanical playing, usually in the form of a pneumatic system controlled by a perforated paper roll. About two million such instruments were made in the United States during the peak years of 1900 - 1930. In standard player pianos, the roll controls only which hammer will strike when and how long the dampers will remain lifted -- basically, what note sounds when. There is no provision for changing dynamics or for pedaling. (In some cases, a person at the piano during performance could exercise a degree of expressive control by operating wind pressure and roll speed levers for dynamics and tempo variation.) The more sophisticated and expensive reproducing pianos, on the other hand, incorporated dynamics and pedaling information on the roll. Common player pianos inevitably have a slightly mechanical quality to their playing. But a good reproducing piano, if all its mechanical parts be carefully regulated, can sound remarkably as if the performer who made the original roll is actually present and playing your piano. The rolls for both types could be made by hand (as Conlon Nancarrow has done in more recent years), or, alternatively, during what would now be called real time performance (with the possibility of touching up or editing later). From the resulting masters, copies could be produced in mass. Leading concert artists of the day were sought out to record on the paper rolls just as recording artists are today.

And this brings us to an important point. While mechanical instruments were limited in some respects, they were in one rather important sense superior to vinyl and tape: when you are there in the same room with the actual sounding instrument -- the music box or player piano or whatever it may be -- you hear its own, unadulterated, three dimensional sound in its natural state. That's not high fidelity; that's not low fidelity; that's just firsthand music. Movement of electrons in one dimensional wires is not the same. It's true that many mechanical instruments are pretty hokey sounding -- few have the refinement of reproducing pianos -- but natural sound is surely worth something.

OK, we've answered questions from an imaginary audience on orchestrions and player pianos. I now direct any further inquiries to David Bowers and his ...

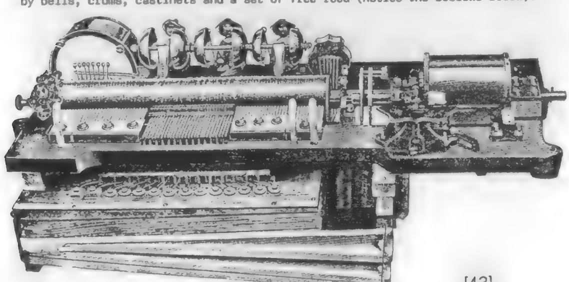
ENCYCLOPEDIA OF AUTOMATIC MUSICAL INSTRUMENTS

David Bowers' book is a huge work of over a thousand pages, and reasonably priced for something of its magnitude at around $50. Bowers divides his subject into chapters devoted to the major categories of mechanical instruments, which he sees as Cylinder Music Boxes, Disc Music Boxes, Player Pianos, Reproducing Pianos, Coin-Operated Orchestrions, Organettes (player organs), and Fairground Organs. This division takes the place of the alphabetic entries used in other encyclopedias, but an extensive index helps ensure easy access by subject matter, along with a dictionary of automatic musical instrument terms and a bibliography.

Bowers starts each chapter with an introductory essay reviewing the basics for the instrument category in question. This is followed in each case by a great wealth of photographs of instruments and instrument innards, with generous accompanying captions and informational notes. There are also reproductions of original commercial promotional materials and owner's manuals, items from the newspapers of the day, and several essays from other present day authors on the instruments and their workings.

Bowers descriptions of the mechanical workings of the various instrument types are more general than detailed. Mechanical drawings do not appear, except when they happen to be included among historic materials that are reproduced. With the great abundance of diverse materials included, though, most of what you might want to be know can be gleaned. There is likewise little space devoted to acoustics. That is not inappropriate: most of the instruments use familiar sounding elements whose principles are no different from those of standard instruments.

IDEAL ORCHESTRA music box, circa 1895. The familiar plucked comb is augmented here by bells, crums, castinets and a set of free reed (notice the bellows below).



The photos are inconsistent in quality; some are quite poor, and the layout is not always flattering. Also there is a recurring problem with scaling: it's often difficult for one not already familiar with the instruments to resolve whether a depicted object is an inch long or a foot long.

In total, the book is one big hodge-podge: truly glorious in many ways, and certainly a bit confusing and disorganized at times as well. Its informational value, especially in abundant visuals, is indisputable. There's so much to be seen in them;

so much to learn from them! And in net effect they roundly convey the wonderful spirit of mechanical inventiveness that the author celebrates.

THE STORY OF THE VIOLANO VIRTUOSO

"The Story of the Violano Virtuoso" is a 32 page pamphlet produced shortly after the turn of the century by the Mills Novelty Company to promote their self-playing violin and piano combination. The good people at Vestal Press got hold of the pamphlet, and have reproduced it for latter day Violano aficionados. In the flowery language of early American commercialism, it extols the virtues of the Violano Virtuoso, beginning with "One of the Truly Great Achievements in the History of Music" and ending with "A Remarkable Investment for the Modern Merchant." The pitch is slanted to the owner of commercial property wanting to attract additional clientele. The anonymous author's descriptions of the instrument itself and the processes by which it is made, though perhaps overly praiseful in tone, are reasonably clear and complete (but for some references to secret processes). There are quite a few pictures of the instrument and the techniques used in making it.

The Mills Novelty Company was not originally an instrument making firm, but primarily a manufacturer of gambling machines and arcade games. Around 1900 the company began marketing music machines, first selling products of other manufacturers under its own name, and later manufacturing its own. In 1905 Henry Sandell, one of the company's inventors, produced a solo automatic violin player. It was only modestly successful. By 1910 Sandell had added an accompanying piano mechanism to create the Violano Virtuoso celebrated in this pamphlet. It sold well and in time became a popular classic. A number of them are still around today, in varying states of repair.

Violano Virtuoso music was recorded on paper rolls, which in turn operated an electro-magnetic action. The Mills people regularly produced new rolls with different compositions, and sold them to Violano owners through a monthly bulletin listing new releases. The instrument used a violin very much like a standard violin, but slightly heavier in construction. Four small rotating conical celluloid disks, automatically rosined, bowed the four strings. There was a code for recording expressive dynamic changes on the paper roll, and these were realized in the violano by changes in the bowing pressure and rotation speed. A set of small bars with V-shaped grooves at the end, one for every chromatic stopping point on each string, performed the function of the violinist's left hand. The piano section of the Violano Virtuoso had 44 strings, arranged with the longest in the center, sounded by electromagnetically controlled hammers.

The sound of the Violano Virtuoso (which can be heard on the record reviewed below) is not crude or mechanical in nature; indeed it is rather refined. It turns out to be quite different, though, from a violin in human hands. The perfect uniformity of the rotating bow stroke on the string produces a sound akin, interestingly enough, to an organ reed pipe -- which suggests how much our sense of instrumental timbre really depends upon envelope, characteristic approaches to pitch, the nature of the attack and release, associated transients and such. Also unlike a human violinist, the Violano is capable of fully independent double, triple and quadruple stopping, and these effects are used liberally in the Violano arrangements. The piano in the Violano Virtuoso, meanwhile, sounds very much like the standard instrument (not surprisingly, since pianos are highly mechanical devices to begin with), and provides a tasteful and nicely balanced accompaniment.

THOSE MAGNIFICENT MUSIC MACHINES

Those Magnificent Music Machines is one of several recordings of mechanical instruments offered as LPs or cassette tapes by the Vestal Press. The instruments presented here are from the collection of Doyle H. Lane in Vancouver, British Columbia. Eleven instruments appear in all; a diverse set of classic machines they are, and seemingly (to my unpracticed ear) well maintained and regulated. Among the instruments included:

A Duwyn Dance Organ, playing "Truly Fair" and Zambesi." This instrument, made in Belgium in 1915, is based in flue and reed pipe organ sounds, augmented by an accordion, with generous helpings of bass drum, snare drum and castanets thrown in. One of the pieces is a polka; the other is similar in spirit but a little more raggy.

The Polyphon, playing "The Rat Catcher" and "Vienna Blood." This is a music box pure and simple, made around the turn of the century, with comb-style plucked metal prongs sounding element operated by a 24" rotating steel disk. No other effects are included. The sound is simply lovely.

Birdsongs. Since the 1800s mechanical singing birds have been made in Switzerland and later elsewhere. The sound is produced by a mechanism concealed in the base of the mock bird cage consisting of a slide whistle controlled by a contoured rotating wheel. The end of the sliding stopper arm rides up and down on the irregularly-shaped rim of the wheel to alter tube length. This system can produce amazingly convincing bird call imitations.

The Encore Banjo, playing "Oceanic March." The actual banjo heard here has a slightly thin, cheap sound, as if the strings are overplucked or set at low tension, and the tuning up the neck is imperfect. The arrangement of the music is not what could be called banjoistic, in part because the machine can produce a more complete (pianistic?) arrangement than a human player could. A fast tremolo distinguishes the melody line most of the time.

The Welte Brisgovia playing "Hot Lips" and a set of Brahms Hungarian Dances. The Brisgovia is a classic orchestrion, this one originally built

ORCHESTER PIANO, 1903. A player piano with drums operated by a perforated cardboard roll.

on special order for James Ward Packard of the automotive Packard family. This grand instrument contains innumerable reed and flue pipes, piano, xylophone, bells, bass drum, snare drum, cymbals and who knows what else. But, wouldn't you know it, for all its lavishness, this was one of the least colorful and enjoyable instruments on the LP for me. Just a subjective opinion.

The Chickering Ampico Grand reproducing piano, playing "Polly" and "On the Wings of a Song." The only thing to be said about this instrument is that it really does sound very much like a living player at the keyboard -- and a fairly sensitive one at that.

Also included on the record are a Seeburg KT orchestrion (with piano, organ pipes and percussion), a Tangley Calliope, a Seeburg Style L Nickelodion (piano and mandolin), a Wurlitzer Military Band Organ (march music including big bass drum and low brass sounds), and the Violano Virtuoso.

The record jacket for **Those Magnificent Music Machines** includes just a sentence or two of notes on each instrument, but there is a generous set of seventeen clear (if small) color photographs. The recording quality seems only so-so (no top end), but the spirit is there. Thanks to Doyle H. Lane for gathering together a fine and diverse collection, for seeing to the definitely non-trivial task of bringing the instruments into top operating condition, and for making these precious sounds available on disk.

OTHER RESOURCES FOR INFORMATION ON MECHANICAL MUSICAL INSTRUMENTS

Societies and membership organizations concerned with mechanical instruments include:

The Musical Box Society,
Box 205, Route 3, Morgantown, Indiana 46160
The Automatic Musical Instruments Collectors Association
191 Riverview Dr., Woodville, OH 43649.
The American Theatre Organ Society
PO Box 417490, Sacramento, CA 95841.

Other general books on automatic instruments are:

Buchner, Alexander, **Mechanical Musical Instruments** (London: Batchworth Press, 1955).
Haspel, Jan Jaap, **Mechanical Musical Instruments: Their Mechanics and their Music, 1580 - 1820** (Koedijc: Nirota Muziekdruk, 1987).

There are a few collections of automatic instruments open to the public. Among them are:

The Musical Museum, Route 12-B, Deansboro, NY 13328; (315) 841-8774. A broad collection on display under the slogan "Hands on! Please Touch!"
Musical Wonder House, Wiscassett, Maine. Specializing in Swiss, German and American music boxes.
Musee Mecanique, downstairs at the Cliff House, 1090 Pt. Lobos, San Francisco, CA 94112; (415) 386-1170. Player pianos, barrel pianos, orchestrions, nickelodions & music boxes all in working order and ready to perform for whoever puts a coin in.
The Musical Box Society has a permanent exhibit at the Lockwood Mathews Mansion at Norwalk, Connecticut. MBS also has a temporary exhibit this summer at the National Watch and Clock Museum in Columbia, Pennsylvania.

Many more specialized books, pamphlets and recordings of automatic instruments are available from the Vestal Press, PO Box 97, Vestal, NY 13851-0097.

Thanks to Art Sander, curator of The Musical Museum, for his assistance with this article.

NOTICES

GLASS MUSIC ENSEMBLES or anyone having information about current performing glass music groups -- please send information about these, no matter how obscure or based on rumour -- to E. Cadesky, Glass Orchestra, 211 College St. #115, Toronto, Canada M5T 1R1. Most interested in contemporary and ethnic glass music from North American or other cultures.

ANNOUNCING NEW LEONARDO MUSIC JOURNAL AND CD SERIES, 1991. ARTISTS/RESEARCHERS wanting information on this journal and/or how to submit articles/recordings for inclusion in the journal should send a self-addressed, stamped envelope to LEONARDO MUSIC JOURNAL, Attn: Isabel Maxwell, Music Journal Coordinator, 1442 A Walnut St., Box 75, Berkeley CA 94709, USA.

WEEKEND ON THE WATERFRONT, an arts festival presented by Arts Explosion/Oakland, will include an area called Arts in Process, devoted this year to sound artists and their work. Several instrument makers/sound sculptors will be creating sounding things on the spot; explaining, demonstrating and sharing their work with festival goers. Among the artists: Darrell De Vore, Tom Nunn, Richard Waters, Bart Hopkin, and others to be named. At Estuary Park, Oakland, CA, Sunday & Monday Sept. 2 & 3 (Labor Day Weekend), 1:00 to 6:00. Lots of other good stuff at the festival as well. (415) 444-5588 for information.

NEW JOURNAL OF SOUND: The Aerial is an ongoing "journal in sound", a series of compilations of various kinds of recorded activity leaning towards the experimental. Issue #1, now available, is $12 on CD or $8 on cassette, postpaid. A four issue subscription costs $40 for CD, $30 for cassette, from Nonseq./What Next? PO Box 15118, Santa Fe, NM 87506.

And another offering: SOUNDVIEWS: SOURCES is a cassette-only anthology of 39 audio artists who work outside the bounds of "music" per se -- people who do installations, build instruments, work with environmental sound, etc. $8, post paid, Nonseq./What Next? at the address above.

PLANET HARP is a newly released cassette of original harp music for Ngombi, a traditional harp from Gabon, and the Moon Harp, designed by Catherine Favre, inspired by the Finnish Kantele. Available through Studio Luna, PO Box 252, Half Moon Bay, CA 94019. $10 plus $1 shipping; make checks to Catherine Favre.

1990 Guide to Unusual How-To Sources. Describes over 50 periodicals & handbooks on backyard tech, camping, far away places, finding new friends, gardening, low-cost shelters, off-beat science, travel, etc. All addresses included. Free for SASE. Light Living, POB 190-EX, Philometh, OR 97370.

SONIC DISTURBANCE, Sept. 12-23, 1990. The 2nd annual festival of sound at Cleveland Public Theatre continues its commitment to little-heard audio art, new music, sound sculpture, performance poetry and more. For information write Sonic Disturbance, 1607 Clark Ave., Cleveland, OH 44109; or call (216) 621-8738.

SOUNDINGS 16: AN ANTHOLOGY. The latest from Soundings Press includes material from several sound artists working with new & unusual sound sources: Sarah Hopkins, John Zorn, Gordan Monahan and several more. 176 pages; $20/copy, from Soundings Press, PO Box 8319, Santa Fe, NM 87504-8319.

A REMINDER -- Unclassified ads here in EMI's notices column are free to subscribers for up to 40 words; 30 cents per word thereafter. For others they are 30 cents per word, 15 word minimum, with a 20% discount on orders of four or more insertions of the same ad.

Newly published: 20TH CENTURY MICROTONAL NOTATION by Gardner Read is a comprehensive investigation of modern approaches to notation of microtonal music. Cloth bound. $39.95 from Greenwood Press, 88 Post Rd. West, PO Box 5007, Westport, CT 06881.

SAMPLER HOME USERS ASSOCIATION is an organization devoted to study and enjoyment of the possiblities and/or uses of the sampler as a technical instrument for creation, through the establishment of an international network for exchanging recordings. For more information contact Francisco Lopez, Apartado 2542, 28080 Madrid, Spain.

URBAN SPACE EPICS is a culmination of years of experimentation with Kalimba tunings, extended vocal techniques and intensive research into ancient world poetry. The epic-songs (improvised poems along a loose structure of dramatic points and archetypal images) include "Song to Ishi", "L.A. Woman Meets Maria Sabina", "The Possum", and "Lullaby". An instrumental "Walking" is performed on a Kalimba using a tuning found among the peoples of Mozambique. The final work on the tape, a satirical rant entitled "Out on Insanity," is dedicated to Lenny Bruce. Urban Space Epics by Darrell Jonsson is available from Missing Link Music / 6920 Roosevelt Way N.E. #328, Seattle, WA 98115 for $6.50 + $1 postage.

DIDJERIDUS -- Play this aboriginal wind instrument yourself. Find out why composers & players of avant garde and experimental music are re-discovering the oldest wind instrument in the world. Instructional cassette included. $85.00. For information call or write Fred Tietjen, 26 Allen, San Francisco, CA 94109; (415) 474-6979.

THE CARROT went to see the doctor. "Well Doc," he says at the end of the examination, "what's the prognosis?" "Can't say yet," says the doctor. "Check back tomorrow after I run some tests." The carrot returns the next day. "Well, I've got some good news and some bad news," says the doctor. "The good news is -- you're gonna live. The bad news is -- you're gonna be a vegetable for the rest of you're life."

THE ONLY BOOK IN SAWING: **Scratch My Back: A Pictorial History of the Musical Saw and How to Play It**, by Jim Leonard and Janet Graebner. Features profiles of sawyers world-wide in 124 pages of fascinating information. Includes over 100 photos and illustrations, index and bibliography. U.S. Dollars $19.95, $3 shipping/handling (in CA add 6% tax). For information, contact Janet E. Graebner, Kaleidoscope Press, 1601 West MacArthur, #12F, Santa Ana, CA 92704.

MICROTONAL MIDI TERMINAL by Denny Genovese is a real time performance program for just intonation on virtually any MIDI controllable musical instrument; also a powerful tool for analyzing & constructing microtonal scales. System requirements: IBM PC, XT, AT or compatible with 128K, DOS, Roland MPU- 401 or compatible MIDI interface, MIDI controller and MIDI controllable musical instrument. $50. Denny's Sound & Light, PO Box 12231, Sarasota, FL 34278.

JUST INTONATION CALCULATOR by Robert Rich. Composer's tool for JI. Internal sound for tuning reference; shows modulations; reduces fractions; converts between ratios, cents, DX7II/TX81Z units; MIDI tuning dumps. Requires Macintosh with Hypercard -- only $10.00. Soundscape Productions, Box 8891, Stanford, CA 94309.

EMI BACK ISSUES: Back issues of **Experimental Musical Instruments** numbered Volume VI #1 and later are individually available for $3.50 apiece. Earlier issues available in volume sets of 6 issues each, photocopied and bound: Volumes I through V, $14 per volume. Order from EMI, PO Box 784, Nicasio, CA 94946, or write for complete listing. Corresponding cassette tapes also available for each volume; see information below.

MAKE A FLUTE!, a 32-page softcover book by Mark Shepard, offers general guidelines on designing flutes, plus tips on working with the material of your choice. Mark Shepard is the author of Flutecraft and How to Love your Flute: A Guide to Flute Playing. Make a Flute! can be ordered from Simple Productions, 12 East 15th St., #3, Arcata, CA 95521, for $5.00 U.S. postpaid.

CALL FOR ARTICLES: The International Horn Society has introduced a new refereed Journal, Horn Call Annual. Scholarly articles dealing with the horn are solicited. For further information contact Paul Mansur, Editor, the Horn Call Annual, 2227 Gershwin Dr., PO Box 1724, Durant, OK, 74702-1724; phone (405) 924-5859.

CASSETTE TAPES FROM EMI: **From the Pages of Experimental Musical Instruments**, Volumes I through V, are available from EMI at $6 per volume for subscribers; $8.50 for non-subscribers (each volume is one cassette). Each tape contains music of instruments that appeared in the newsletter during the corresponding volume year, comprising a full measure of odd, provocative, funny and beautiful music. Order from EMI, Box 784, Nicasio, CA 94946.

RECENT ARTICLES, continued from page 24

The summer 1990 issue of Connections, the newsletter of the Music for People organization (RD 4 Box 221A, Keene, NH 03431) has its usual complement of ads and notices for interesting and unusual instruments and approaches to music making. This issue focuses on music and children (the cover has a great picture of a youngster swinging a whirly overhead while holding a percussion bowl in the other hand and a large mallet in his teeth).

CAS JOURNAL (Journal of the Catgut Acoustical Society of America) Vol. 1 #5 (Series II), May 1990 (112 Essex Ave., Montclair, NJ 07042), has as always several noteworthy articles:

WOOD PROPERTIES FROM SAMPLE PLATE MEASUREMENTS I by Graham Caldersmith, and INFLUENCE OF LOCAL THICKNESS CHANGES ON VIOLIN PLATE FREQUENCIES by Oliver E. Rodgers continue CAS's commitment to the investigation of the vibrating patterns and properties of wooden soundboards, and particularly violin top plates.

A SIMPLIFIED MODEL FOR A BEATING REED -- PRELIMINARY RESULTS by W.E. Worman, A.H. Benade and Michael Vadnais, proposes a method for mathematically describing the behavior of a clarinet reed and the waveform of the resulting air pulses.

STRING TONE QUALITY RELATED TO CORE MATERIAL, by Norman C. Pickering, compares measurable tone quality differences (using FFT frequency analysis) between violin strings with core wires of steel, nylon and gut.

The current issue of The String Instrument Craftsman (March-April 1990, Volume 3 #12; 142 N. Milpitas Blvd., Suite 280, Milpitas, CA 95035), features several articles on on-board active electronics for electric guitars. There's also more on the Club, a solid body electric guitar made from a single stick of wood.

FINALLY A SOLUTION TO THE BERLIOZ by Michael Bayard, in Percussive Notes Volume 28 #4, Summer 1990 (Box 697, 123 West Main St., Urbana, IL 61801-0697).

Berlioz' Symphony Fantastique calls for very large bells tuned to C and G. What bells to use? Where to get them? A percussionist recounts his adventures in seeking something with a big enough sound -- a story of moving great weights, climbing tall ladders, swinging padded sledge hammers & arguing with reluctant officials.

Also in this issue of Percussive Notes: TAMBOURINE REPAIR by Brian Stotz -- Two pages of information on materials, techniques & supply sources.

... And in the previous issue of Percussive Notes (Vol. 28 #3, Spring 1990; address above), there are articles on two instruments from non-western cultures: HAND DRUMMING ON THE APENTEMMA, by Joe Rasmussen, discusses this large Ghanaian goblet drum. PROPER ANKLUNG TECHNIQUE, by Geary Larrick, does the same for the Indonesian tuned bamboo shaken idiophone.

American Lutherie #21, Spring 1990 (8222 S Park Ave., Tacoma, WA 98408) contains several valuable articles:

THE MULTI-SCALE FRETBOARD, by Ralph Novak, reports on the author's special fret placement system, with frets slightly fanned out like the famous bandora shown in Praetorius' Syntagma Musicum of 1619. This allows the bass strings to be slightly longer than the treble strings, and reportedly improves sustain, feel, and intonation.

HISTORICAL LUTE CONSTRUCTION: THE ERLANGEN LECTURES, PRACTICUM PART 3, by Robert Lundberg, continues Lundberg's excellent series on historically accurate lute construction.

WOOD TREATMENT AND SIZING MATERIALS, by Rick Rubin, presents a neatly organized review of wood treatments and their effects on stiffness and appearance.

THE MANDOLIN ORCHESTRA IN AMERICA, PART 3: OTHER INSTRUMENTS, by Joseph R. Johnson, continues this series which includes information on and photographs of lots of odd, interesting, beautiful and rare plucked string instruments.

The following is a selected list of articles of potential interest to EMI readers which have appeared recently in other publications.

SOUND AND GESTURE, an interview with background by Helen Hall in Musicworks 46, Spring 1990 (1087 West Queen St, Toronto, Ontario, Canada M6J 1H3).

This is an interview with Fast Forward, a percussionist specializing in extended steel drum technique. A variety of other non-standard percussive sound sources fill out his performances.

RHYTHM AND THE FRAME DRUM: ATTRIBUTES OF THE GODDESS by Layne Redmond in Ear Vol. 15 #4, June 1990 (131 Varick St. Rm 905, New York, NY 10013).

A look at the history of frame drums, with an emphasis on mythic significance and relations to female-based religious systems.

Ear Vol. 15 #3, May 1990 (address given above) has several noteworthy articles:

VIVA VINYL: THE RECORD AS ART, by Tony Coulter, mentions three artists who have worked with records as raw material: Milan Knizac, who in the 60s damaged records in various ways and then attempted to play them; Piotr Nathan, who uses record albums as material for visual art; and Christian Marclay, virtuoso of turntable manipulation and other sonic and visual uses of records.

HOCUS FLUXUS, by Barbara Moore with photographs by Peter Moore, is a short account built around 10 photos of the Fluxus group in performance. Fluxus existed as a performance group from 1962 to 1978. They performed compositions based as much around actions as around actual musical sound, involving misuse of musical instruments, nonmusical behavior presented in formats normally associated with music, silent actions choreographed in musical time, and such.

NEW FACES: LESLIE ROSS, interviewed by Regina Joseph, presents a few quick notes on bassoonist, bassoon-maker and bassoon experimenter Leslie Ross. A recent instrument of hers, described here, is the Tenticled Bellows, using multiple bassoons, flexible drone tubes, and a foot-pedal bellows.

YAMAHA BRINGS MAJORITY OF U.S. UPRIGHT PRODUCTION TO GEORGIA, in The Music Trades Vol. 138 #5, June 1990 (PO Box 432, Englewood, NJ 07631).

This is a report on Yamaha's enlarged piano making plant at Thomaston, Georgia. Of interest are descriptions and photographs of manufacturing operations at a large, modern plant.

SOUND TOOLS FOR THROWING AND FOLLOWING: AKIO SUZUKI'S SOUND PERFORMANCE by Toshie Kakinuma, in High Performance #50, Summer 1990 (1641 18th St., Santa Monica, CA 90404).

Japanese sound builder Akio Suzuki creates a variety of sounding objects and listening exercises. This article touches on several of his sounding and listening devices, and his concepts of "throwing" and "following," corresponding to highly conscious, deliberate and studied forms of sound making and listening.

TRIMPIN: CIRCUMFERENCE by Heather Doran Barbieri, also in High Performance #50 (address above).

Trimpin works primarily with computer-controlled, electro-mechanically-played acoustic sound sources. The piece reviewed here uses sound sources placed around the circumference of a hall, with much of the effect based in spatial patterns created by precisely timed and sequenced sound events taking place around the room.

LAW OF TRANSFORMING FORCES by Dale Pond, in Sympathetic Vibratory Physics Vol. V # VII, April 1990 (1309 North Chestnut, Colorado Springs, CO 80905).

This journal is devoted to the work of John Ernst Worrell Keely (1837-1898), who developed a set of physical laws (not credited by mainstream science) based in the idea that all things are connected though sympathetic vibration. This article discusses one of his laws, which describes ways in which widely divergent frequencies associated with different objects can in effect be transposed into closer relationships. Included are brief comments on a device built by Keely to effect such transpositions, composed of a graduated set of metal plates, each harmonically related the its neighbor.

RADIONICS -- ACOUSTIC RESONATORS (no author credited), also in Sympathetic Vibratory Physics Volume V Issue VII (address given above).

This is a one-page discussion of radionics, a technique in which a physical device with tunable elements of some sort is tuned to pitch relationships believed to correspond to "a person, organ, disease or place." Such devices were made by past practitioners using sets of metal rods of adjustable vibrating length.

The Galpin Society Journal XLIII, March 1990 (38 Eastfield Rd., Western Park, Leicester LE3 6FE, England) has 200 pages of articles on diverse instruments, mostly historical. Among them:

In TOWARDS A METHOD OF TESTING HARPSICHORD SOUNDBOARDS, John Rawson uses Chladni patterns and other methods to try to ascertain physical characteristics of good-sounding soundbaords.

In HARP STRINGS OF THE 18th AND 20th CENTURIES, Ian M. Firth and Claire Sykes take advantage of the recent uncovering of a string set from around 1800 to run some comparisons with modern strings.

THE SAXTUBA AND ORGANOLOGICAL VITUPERATION, by Clifford Bevan, describes this short-lived family of instruments (created by Adolphe Sax in Paris and patented in 1849) and their music. "Organological vituperation" refers to an exchange of sarcastic commentary on the instruments between critics of the time.

INJURY TO INSULT by Julia Loktev in Option 32, May/June 1990 (2345 Westwood Blvd. #2, Los Angeles, CA 90064).

Here's another article on Christian Marclay and his offbeat works with records and turntables.

(Continued on page 23)